425

THE

VETERINARY JOURNAL

Editor :

PROFESSOR T. DALLING, M.A., M.R.C.V.S.,
Professor of Animal Pathology and Director of The Institute of Animal Pathology, Cambridge University

Sub-Editor :

PROFESSOR J. McCUNN, M.R.C.V.S., M.R.C.S., L.R.C.P.,
Professor of Anatomy, The Royal Veterinary College

DECEMBER, 1940

Editorial

POULTRY DISEASES

In this number of The Veterinary Journal we publish two articles on diseases of poultry. One deals with fowl paralysis—a disease which has been very prevalent in this and other countries for a number of years. It has caused heavy losses in many flocks and for a considerable time the results of research work seemed to be confusing. Within recent times, however, the general characteristics of the disease have become more apparent and it has been shown that the recognised lesions of the disease can be set up by the injection into susceptible fowls of certain tissues of affected fowls. It would seem, therefore, that there is now a considerable amount of evidence concerning the infective nature of the disease. One of the important features of recent research work is the demonstration of the resistance and susceptibility of different strains of fowls to the infection. This observation has been recorded on several occasions in the past. The association of infection with the causation of fowl paralysis fits in well with the history of outbreaks in

XUM

the field and should, in some measure, give a lead to the methods to be adopted in the control of the spread of the disease.

The other paper deals with a disease in young chicks—encephalomalacia—and describes lesions in chicks in this country which bear a marked similarity to those found in that disease in other countries.

It may be argued by some that because of the present policy of the Government to restrict greatly the supply of imported food to be issued to poultry-keepers, the necessity to continue with research into diseases of poultry is no longer an urgent problem. We cannot subscribe to such a view. There are undoubtedly many diseases of poultry still imperfectly understood and the more we can learn about their cause, nature and control, the more can measures be applied for their suppression: if it is necessary to reduce poultry stocks throughout the country, it is imperative that the stocks to be retained should be as free from disease as our present knowledge will allow. The more we learn concerning diseases, the healthier will be these stocks—an important point for future replenishments. The veterinary profession must continue to play its part in the research into, and control of, poultry diseases as much as of any other class of livestock.

THE PASSING YEAR

ANOTHER year is nearly gone—a year full of changes. No one could have forecast a year ago the present state of world affairs at this time. What the New Year will bring forth remains to be seen. We are tempted to ask whether we, as a profession, have played a conspicuous part in the national effort during the past year. To many of us the work we have had to undertake has differed but little from that we carried out in times of peace. Others have had to make great alterations in their lives and seek work in new districts: others, unfortunately, find themselves with much less work to do. To those who have had misfortunes, we extend our sympathy.

The veterinary profession has an important part to play in the national effort to conserve and increase the supplies of food in this country. Efforts are now being made in several quarters which, if brought into being, will ensure that the profession is used to its utmost capacity. We can anticipate changes in 1941 and are confident that the veterinary profession will play its part in the national effort.

As 1940 closes, we look forward with hope, courage and confidence to the New Year.

General Articles

FOWL PARALYSIS. TRANSMISSION OF INFECTIVE AGENT TO YOUNG CHICKENS

By R. E. GLOVER

Farm Laboratories, National Institute for Medical Research, Mill Hill, London, N.W.7

PRIOR to 1929 the etiology of fowl paralysis as it occurs in this country was uncertain. As pointed out by Blakemore (1939), various theories had been advanced, such as dietetic deficiencies, infestation with different types of parasites, a neoplastic syndrome, etc., but none afforded a satisfactory explanation of the extensive spread of the disease in a relatively short period of time. The experiments undertaken by Blakemore (1939), and Blakemore and Dalling (1939), however, have clarified the position and have indicated in a satisfactory manner that certain forms of the disease are infective and regularly inoculable. It would appear that the success of these experiments depended to a large extent upon the use of very young chicks for the reception of the infective material and possibly upon the selection of a highly susceptible strain. The disease induced in the young chicks was acute and often fatal. At first sight it bore no immediate resemblance to the forms of neuro-lymphomatosis which are commonly encountered in field outbreaks, since the most striking lesions were a focal necrosis of the liver, effusion into the pericardial sac and infiltrating lesions in the myocardium. It was found, however, that if the experimental birds, which did not succumb to the injection of infective suspensions, were kept for sufficiently long periods, leg and wing weakness with typical infiltration of the nerves developed, while lymphomatous tumours eventually appeared. The suggestion was therefore advanced that these manifold tissue reactions were related to a single infective agent.

The object of the present note is to record the establishment in the young chick of a strain of neuro-lymphomatosis obtained from a turkey (Andrewes and Glover, 1939). The bird was affected with paralysis involving both legs and wings, and showed at post-mortem marked enlargement of the sciatic and brachial nerves. The histological changes were identical with those seen in neuro-lymphomatosis of the fowl.

Transmission of Strain to Young Chicks

Suspensions prepared from a mixture of liver and heart and from an enlarged sciatic nerve were inoculated intraperitoneally into Brown Leghorn

TABLE I

Serial passage of infective agent through 16 generations

	No. of chicks	Died	Killed		Lesions at post-mortem					Lesions by routes other than intra-peritoneal
			Earliest day	Latest day	Liver	Heart	Kidney	Nerve	Tumour	
Original	10	0	27	126	6/10	1/10	1/4	0/2	0	
1	11	2	26	102	6/11	3/11	2/3	0/3	0	
2	7	1	24	96	6/7	3/7	—	—	0	
3	9	2	24	96	8/9	3/7	—	—	0	
4	8	0	28	136	7/8	5/8	—	—	0	
5	8	0	18	101	5/8	4/8	3/4	1/3	0	
6	11	0	18	100	10/11	9/11	1/3	1/5	0	
7	13*	0	18	76	13/13	11/13	1/3	1/2	0	*1 I.C. ++ 1 I.N. +
8	14	2	17	45	8/13	6/13	—	—	0	
9	15*	2	12	45	14/15	11/14	—	—	0	*2 I.N. ++++ 2 I.C. −
10	12	0	22	60	9/12	10/12	—	—	0	
11	11	1	21	99	9/11	10/11	—	—	0	
12	13*	1	19	69	9/13	9/12	—	0/3	0	*1 I.M. ++ 2 I.V. ++++ 2 I.C. ++++ 2 I.N. ++
13	15	0	13	69	7/15	6/15	—	—	0	
14	10	3	20	57	12/14	9/12	—	0/6	0	
15	13	0	18	46	11/15	6/11	—	—	0	
16	18	0	20	38	13/18	5/9	1/6	—	0	

The difference between "No. of chicks" and number with "lesions at p.-m." is due to the fact that in a proportion of cases a complete histological examination was not undertaken.

All chicks inoculated intraperitoneally except those marked *. I.M. = intramuscular.
I.C. = intracerebral.
I.V. = intravenous
I.N. = intranasal.

(B.L.) chickens of from three to ten days of age. The experimental disease was induced with each type of tissue. From these birds a strain was obtained which has been passed through 16 generations (Table I). The disease in the injected birds, particularly in the early part of the series, was relatively mild, since in most instances the only symptom was a marked retardation in the rate of growth. The infective agent has thus proved to be less virulent than that described by Blakemore. For example, the death rate has been very low since out of 198 chicks only 14 have died. By repeated passage, usually at three-weekly intervals, the lesions at autopsy became more apparent. In the early stages the sole changes were a slight mottling of the liver and paleness of the myocardium, but later more or less extensive irregular white lesions were noted in the liver, the pericardium contained an excess of a clear fluid and the heart muscle was often beset with whitish foci or streaks. In most instances transmission of the virus was maintained by the intraperitoneal route, but typical lesions were also obtained after intravenous and intramuscular injections.

The experiments of Blakemore are particularly interesting as indicating a difference in susceptibility in various strains of chickens. He states that two stocks were available : one had been derived from a strain which had been heavily infected with fowl paralysis but had been freed from the disease by selective breeding, while the other was a strain in which the disease had never occurred. The susceptibility of the former was on a higher plane than that of the latter.

The birds used in the present investigation were obtained from a normal strain which is believed to be free from neuro-lymphomatosis, although formerly fowl paralysis had been detected in the original stock. Rigorous selective breeding led to an apparent elimination of the disease from the breeding pens. It was considered advisable, however, to control each step in the investigation by including a number of uninoculated birds in each experiment and by injecting chicks with tissues from normal adult birds belonging to the strain from which the experimental chicks were derived. It was found that no lesions suggestive of fowl paralysis occurred in any of the normal chicks. In one instance in a group of six chicks inoculated with a liver and heart suspension from a " normal " bird, two chicks showed at post-mortem a slight mottling of the hepatic tissue which, on section, revealed discrete lymphocytic foci. Passage of this material to a second group of chicks failed to induce any recognisable changes. It is considered unlikely, therefore, that latent fowl paralysis virus was present in these chicks, unless it is postulated that the virus can remain dormant and can only assume an active form when some other stimulus is applied. Such might have been provided by the turkey tissues, and in order to check this hypothesis six young chicks were injected with a mixed organ suspension from a purchased turkey, which showed no

XUM

evidence of fowl paralysis. When killed at periods varying from 4 to 15 weeks these chicks were completely normal.

The initial transference of the infective agent was made in B.L. chickens. By the fourth passage, however, the numbers of this breed available were insufficient and a certain proportion of Plymouth Rock (P.R.) chicks were included. At post-mortem the B.L. were visibly affected, while no definite lesions were detected in the P.R. Passage of liver and heart suspensions from the P.R., however, produced widespread lesions in B.L. and visible lesions in P.R. chicks.

In order to compare the susceptibility of these two strains to the Cambridge virus, groups of B.L. (10) and P.R. (10) were inoculated with a liver suspension from an infected chick, kindly supplied by Mr. Blakemore. Six were inoculated intravenously and fourteen intraperitoneally. They were killed at intervals ranging from 18 days to 93 days after infection. The virus failed to induce severe changes since no deaths were recorded, while the lesions at post-mortem, although quite in keeping with those described by Blakemore, were not very severe. The impression was gained that both B.L. and P.R. strains were less susceptible than the Cambridge strain. Further passage might have resulted in an increase in the severity of the lesions, but this experiment was not attempted.

Histology.—The microscopical changes in injected chickens have been adequately described by Blakemore. Since the agent under discussion produced lesions which, in general, were of a very similar character, no detailed account is considered necessary, but brief reference may be made to the marked stimulation of endothelial tissues, probably due to the higher resistance of the experimental chicks to infection. Once the strain was established recognisable foci were generally seen in the liver and heart, and occasionally in other sites.

In the liver four types of tissue reaction, occurring separately or together, could be detected, viz.: (1) a diffuse cytoplasmic degeneration of the hepatic cells in which the extra nuclear substance was paler than the normal and slightly granular: this change was usually accompanied by fatty degeneration; (2) well-defined foci of lymphocytic cells, generally near the central veins or in proximity to the vessels associated with the bile ducts; (3) sharply circumscribed areas of necrosis of the hepatic cells with a periphery of inflammatory tissue. In the more advanced stage the degenerate sites were invaded with leucocytes; (4) proliferation of the reticulo-endothelial cells. In the early stages of the experiment the stimulation of the reticulo-endothelial system was relatively mild, but with continued passage the infective agent tended to provoke this group of cells to a greater extent. In some instances the process seemed to start in the endothelial cells of the blood vessels. Reticulo-endothelial proliferation was by no means confined to the liver, but was also seen in other organs, especially the heart and the kidney. Remote stimulation

XUM

of these cells was a particularly characteristic feature of intracerebral inoculation. For example, eight chicks were inoculated in the brain with a centrifuged liver suspension and were killed at weekly intervals. No macroscopic lesions were noted with the exception of a slight increase in the pericardial fluid, but sections showed a well-marked, diffuse proliferation of the reticulo-endothelial cells in the liver, heart, kidney and spleen.

The changes in the pericardium and myocardium also varied and were more severe with progressive passage of the virus. The pericardium was usually irregularly thickened, while the cavity contained a fibrinous exudate liberally infiltrated with lymphocytic cells and larger cells of the plasma type. The muscle fibres in more advanced cases showed some evidence of degeneration in the form of a loss of staining affinity. In some instances well-defined foci of lymphocytes were noted, particularly towards the margins, while in others, cells of the histiocytic type predominated. These cells frequently formed a veritable network which spread between the muscle fibres. The distribution of these cells showed a striking resemblance to the invasion of nerve fibres seen in natural cases of neuro-lymphomatosis. It has already been pointed out (Blakemore and Glover, 1934) that in early fowl paralysis before the actual infiltration of the nerves has taken place, the neural fibres are disrupted through the pressure of an œdematous fluid. Exudation into the pericardium also takes place at an early stage. It is highly probable that the first action of the virus is to provoke this exudation and that the cellular response is a subsequent step in the process.

Routes of Infection.—As shown by Blakemore, the virus can be transmitted by the subcutaneous, intramuscular and intraperitoneal routes. In the present series all three methods have been used with success and have resulted in the production of lesions of moderate extent. The intravenous route, on the other hand, has proved particularly effective. The injection of well-centrifuged suspensions of infective tissues has been followed by widespread lesions in the liver, heart or both. Characteristic changes have also been noted in the liver and pericardium after intracranial inoculation. In such instances the injected chicks have shown no evidence of cerebral disturbance and the lesions in the brain have been confined to a slight lymphocytic invasion of the meninges.

Some rather interesting results have been obtained from inoculation by the intranasal route. In one experiment a series of chicks was infected with a suspension of liver. The supernatant fluid from a lightly centrifuged emulsion was instilled into the nasal fossæ by means of a syringe and fine needle, the chicks having been previously anæsthetised. Beyond a check in the rate of growth, the birds showed no marked abnormality until the 21st day when three out of six presented definite weakness. All the birds were killed and were affected with extensive heart and liver lesions. The lungs showed no

XUM

macroscopic evidence of disease, but on section there were numerous lymphocytic foci.

Period of Infectivity of Organs.—Evidence has been obtained in previous studies (Pappenheimer, Dunn and Cone [1929], Dalling and Warrack [1936], Blakemore and Glover [1934], etc.) that the development of clinical signs of fowl paralysis following the injection of virulent material is often considerably delayed, but it does not necessarily follow that the virus is not present in the organs at an earlier stage. Under natural conditions, gross involvement of the peripheral nervous system is rarely seen before the third month, although the established fact that the agent passes through the egg presupposes that in a proportion of cases infection is present at the time of hatching. Little evidence has yet been advanced as to the longevity of the infective agent in the organs of the chick, but it is highly probable that it is fairly persistent. The lesions in the liver and heart appear to attain their maximum development between the fourth and tenth weeks; thereafter they tend to retrogress. In the present study the presence of the causal agent has been established from the 12th to the 132nd day after infection. One hundred and ninety-eight chicks have been injected of which 153 have shown positive lesions at post-mortem.

With few exceptions tissues from the experimental birds have been subjected to a microscopical examination. In all cases sections have been prepared from the liver, and in most instances the heart; occasionally other organs such as kidney and nerve have been included. Typical lymphocytic infiltrations in the peripheral nervous system have been noted on a few occasions, but generally the nerves were apparently normal. This observation was not unexpected since most of the experimental birds were killed at a relatively early stage after injection. The evidence obtained from the field and from experimental inquiries indicates that the neural changes are a late manifestation of the disease and would not be apparent in very young birds. Table I summarises the result of the passage experiments.

Transmission with Dried Virus.—Two experiments have been performed to determine the resistance of the virus to drying. In the first the livers from three chicks showing extensive necrotic lesions were minced, spread in thin layers in Petri dishes and dried over $CaCl_2$ in an evacuated desiccator. A scaly mass was formed which was readily reduced to a fine, dry powder and stored in sealed ampoules in vacuo at 0 deg. C. The persistence of infectivity of the dried liver was tested by the intraperitoneal injection of weighed amounts of powder suspended in broth saline. The results of this and a second similar experiment are shown in Table II. The lesions in the liver were usually very extensive and were quite typical. It would appear, therefore, that the infective agent is relatively resistant to drying. Tissues can also be stored for a short period in 50 per cent. glycerol buffer. In the one experiment on the loss of potency under these conditions a positive result was

obtained at the fourth week, but the tissue (liver) was negative at the eighth week.

The disease has also been induced by filtrates through "gradocol" membranes, but full details of the results are not yet available.

Serum-virus Mixtures.—The evidence advanced by Dalling and Warrack (1936), Blakemore (1939) and others suggests that certain breeds or strains of fowl are more resistant to neuro-lymphomatosis than others. It is not clear as to whether this immunity is (a) a type of natural resistance, (b) an acquired immunity resulting from a selective action of the virus whereby the more

TABLE II

Duration of Infectivity of Dried Virus

Dried Liver. Days	*Dose. mg.*	*Number Positive*
3	50	3/3
67	50	4/4
119	50	3/3
	5	2/3
124	10	3/3
	1	2/3
	0.1	2/4
	0.01	1/4
	0.001	0/3
135	30	4/6

susceptible members of a breeding stock are eliminated, or (c) the result of previous exposure to infection during early life which induces an active immunity. So far all attempts to reveal an acquired immunity have been inconclusive. Nevertheless, the observation that the infective agent is filterable naturally suggests that antibodies might be elaborated during the course of the disease.

Several experiments have been performed to determine whether serum obtained from chicks infected with the acute form of the disease would neutralise the agent "in vitro" or induce a passive immunity.

In one such experiment the serum was obtained from four chicks inoculated intraperitoneally eight weeks previously with a suspension of infective liver: all the birds showed typical lesions at autopsy. The serum

XUM

heated to 56 deg. C. for one hour was mixed with the supernatant portion of a broth saline suspension of infective liver and heart previously centrifuged for five minutes at 2,500 r.p.m. After six hours' contact at room temperature the mixture was injected intraperitoneally into ten chicks which were killed six weeks later. The result, as set out in Table III, clearly indicates that under the conditions of the experiment, there was no detectable inactivation of the virus. Other experiments with slight modification have given a similar answer.

TABLE III

Effect of Immune Serum on Virus

No. of chicks	*Inoculum*	*Liver Lesions*			
		Extensive	*Moderate*	*Slight*	*Negative*
6	Immune serum and virus	5	1	—	—
3	Normal serum and virus	2	1	—	—
3	Immune serum only	—	—	—	3
3	Virus only	2	1	—	—

The injection of these sera into normal birds has also failed to afford any protection. Thus eight birds (ten days old) received 0.5 c.c. of serum subcutaneously. Two days later they were injected by the same route with a suspension of infective liver. When killed between the fourth and sixth weeks after the commencement of the experiment, hepatic and myocardial lesions were found which were as extensive as those occurring in four normal birds infected with virus at the same time.

Immunization with Formolised Tissue.—An attempt was made to raise the resistance of young chickens by the injection of virulent tissue treated with formalin. Fully active desiccated liver was triturated with saline to make a 10 per cent. suspension to which was added sufficient formaldehyde to give a 1-2,000 dilution. The mixture was incubated at 37 deg. C. for 24 hours, held at ± 0 deg. C. for a further ten days and neutralised with ammonia. Three birds injected intraperitoneally with 2 c.c. of this vaccine were free from lesions when killed six weeks later. A series of twelve four-day-old Brown Leghorn chickens was injected intraperitoneally with 0.5 c.c. followed

by a second dose of 1 c.c. ten days later. Six weeks after the last dose all the vaccinated birds, together with twelve uninoculated controls of the same age, were injected intraperitoneally with a suspension of fresh virulent liver. Equal numbers of birds from each group were killed 37, 51 and 63 days respectively after the test dose. The results, which are set out in Table IV, show that there was no evidence of protection in the vaccinated group.

Comparison with Other Strains.—At an early stage in the investigation an impression was gained that the lesions in our experimental birds were less severe than those described by other workers. It is known that there are variations in the susceptibility of different strains of chickens and the fact

TABLE IV

Vaccination with Formolized Tissue.

	Formolized 4 4 *vaccine*	*Controls*
Number with macroscopic lesions ...		5
Number with microscopic lesions only ...		5
Negative	4	2
Total	12	12

that we were working with Brown Leghorn and Plymouth Rock strains may have been a determining factor. It had to be borne in mind, however, that the original inoculum was derived from the turkey and that this strain might have been less virulent for chickens. In order to check this supposition a strain of fowl virus, kindly supplied by Mr. Blakemore, was tested simultaneously with the turkey virus. Typical hepatic and myocardial lesions were induced in young Brown Leghorn chickens but they were of moderate extent and failed to provoke the deaths of any of the birds. They were no more widespread than those produced in chicks of the same age and breed injected with the turkey strain.

In addition a strain obtained from a field outbreak of fowl paralysis in Hertfordshire was readily adapted to the Mill Hill stock of Brown Leghorn chickens: again the lesions induced were characteristic but not of undue severity, while the infective agent showed no evidence of enhanced virulence after passage through four generations in young chickens. These results seem to imply that the Brown Leghorn and Plymouth Rock stocks at Mill Hill are slightly less susceptible than the Cambridge P. strain.

XUM

Discussion

The investigation which forms the basis of this paper has confirmed the observations of Blakemore on the recovery of a transmissible agent from field cases of neuro-lymphomatosis which induces acute focal lesions in the liver and heart of the young chick. The majority of the experiments have been performed with a strain isolated from a turkey showing typical lesions of the disease, but a similar agent has also been recovered from clinical cases in chickens.

The infective agent has been transmitted through 16 generations without showing any appreciable qualitative changes. Necrotic or proliferative lesions have been found without exception in the liver, while pericardial and myocardial reactions have usually been seen.

The exact relationship of the experimental disease in young chicks to naturally occurring neuro-lymphomatosis was not completely solved by Blakemore who considered it conceivable that two entirely different infective agents had been passaged in the injection material, one giving rise to the visceral lesions found in the more acute stages of the disease, and the other producing a lymphomatous response as a direct effect of the agent. He pointed out, however, that the atypical lesions and true lymphomatosis occurred in the same fowl or in fowls of the same injected group and that a study of the lesions in all stages of their development strongly suggested that one agent only was present in the injected material. He thought that the initial effect of the agent was probably represented by the early inflammatory lesions in the acute disease and that the true lymphomatous response found in typical fowl paralysis might represent a later more chronic stage of the infection. This point of view is fully endorsed by the results of the present study.

It is conceivable that the virus under consideration is not the cause of true fowl paralysis, or, alternatively, plays only a part in its ætiology. This hypothesis does not explain, however, the apparent presence of the virus in widely separate outbreaks of typical neuro-lymphomatosis and it is more probable that the frankly inflammatory type of reaction as seen in the liver and heart does occur in chickens as an early manifestation but is overlooked owing to the fact that most infected birds are not examined post-mortem until they show signs of leg or wing weakness. In our series the number of birds with cellular infiltrations in the peripheral nervous system was relatively small, but this is attributed to the conditions of the experiments which prevented the maintenance of infected birds in isolation for a period sufficiently long to permit the development of nerve lesions.

Particular attention has been directed to the possible association of the experimental disease under consideration to other conditions of the blood-forming organs. Several workers have claimed that there is a clear relationship between neuro-lymphomatosis and various types of fowl leucosis (Furth,

1931; Bayon, 1931; Patterson, 1936; Lee, Wilcke, Murray and Henderson, 1937, etc.).

In the course of our experiments differential blood counts were made on several occasions and sections of bone marrow and spleen were prepared from infected chickens. Apart from a slight lymphocytosis comparable with that described by Blakemore and Glover in their earlier work, no charactertistic changes were found in the blood-forming organs. It may be suggested that a study of the hæmatogenous and neoplastic tissues of the fowl may be complicated at times by the existence of subclinical or inapparent affections. It is highly probable that the injection of a fresh agent is capable of revealing the presence of another which has remained latent and has passed undetected. Great care has, therefore, to be exercised in interpreting results as representing a transmutation of one form of disease to another, e.g., leucosis into a frank tumour.

Furth (1934), Stubbs and Furth (1935) describe cases of sarcomata associated with leucosis and claim to have provoked with a single agent either changes in the blood stream or sarcoma. It may be noted, however, that Furth himself (1934) admits the danger of introducing a second agent in the course of such experiments.

Conclusions

1. An infective agent, isolated from the tissues of a turkey showing typical lesions of neuro-lymphomatosis, produced lymphocytic and necrotic lesions in the liver and heart of very young chicks of the Brown Leghorn and Plymouth Rock strains.

2. The infection was passed through sixteen generations without demonstrable modification. Transmission was secured by the intraperitoneal, subcutaneous, intravenous, intracerebral and intranasal routes.

3. Attempts to produce an immunity to the agent in chicks were unsuccessful, nor were neutralising antibodies demonstrated. These failures may have been due to inability to control quantitative factors.

REFERENCES.

ANDREWES, C. H., and GLOVER, R. E. (1939): *Vet. Rec., 51,* 934.
BAYON, H. P. (1931): *Vet. Rec., 11* (N.S.), 907; (1933): *Proc. 5th World Poultry Congress.*
BLAKEMORE, F. (1939): *J. Comp. Path., 52,* 144.
BLAKEMORE, F., and DALLING, T. (1939): *Proc. 7th World Poultry Congress,* 282.
BLAKEMORE, F., and GLOVER, R. E. (1934): *Rept. Inst. Anim. Path. Camb., 4,* 51.
DALLING, T., and WARRACK, G. H. (1936): *Vet. J., 92,* 310.
FURTH, J. (1931): *J. Exp. Med., 53,* 243; (1934): *Ibid., 59,* 501.
LEE, C. D., WILCKE, H. L., MURRAY, C., and HENDERSON, F. W. (1937): *J. Amer. Vet. Med. Ass., 91,* 146.
PATTERSON, F. D. (1936): *J. Amer. Vet. Med. Ass., 88,* 32.
PAPPENHEIMER, A. M., DUNN, L. C., and CONE, V. (1929): *J. Exp. Med., 49,* 63.
STUBBS, E. L., and FURTH, J. (1935): *Ibid., 61,* 593.

XUM

STREPTOCOCCUS INFECTIONS IN DOGS

By F. C. MINETT and A. A. B. ELLIS

Research Institute in Animal Pathology, Royal Veterinary College, London.

THE main object of the work reported in this paper was to test the efficacy of drugs of the sulphanilamide class on streptococcus infections of dogs. Incidentally, we wish to set out such information on the subject as we have been able to collect from breeders and from our own observations.

Stafseth, Thompson and Neu (1937) reported the isolation of hæmolytic streptococci from various situations in dogs, e.g., vagina of bitches and from the lungs and other organs of pups dying a few days after birth. Streptococci with similar characters were also isolated from abscesses in dogs. Stafseth (1940) pointed out that streptococci may be isolated from various other disorders in dogs, such as cases of abortion, sterility, septicæmia, pneumonia and tonsillitis. Infected pups which survive may develop arthritis. The syndromes described could not, however, be reproduced by injecting streptococci into dogs of various ages from three days upwards. Previously, Pilot, Buck, Davis and Eastman (1936) had shown that hæmolytic streptococci may be the predominant organisms or be in pure culture in acute tonsillitis in dogs and similar organisms could also be found in small numbers in the tonsils of 12 out of 13 apparently healthy young dogs. Hare and Fry made a clinical and bacteriological study of streptococcus infections in dogs and reported their results in a preliminary communication (1938) and again at the Annual Congress of the N.V.M.A. two years ago (1938).[1] These authors isolated hæmolytic streptococci—mainly belonging to serological groups G and C—from 128 cases. Stableforth (1938) also reports the isolation of hæmolytic streptococci from various conditions in dogs.

Our experience is insufficient to permit us to write with any attempt at finality on the way in which the streptococcus infections of dogs should be classified. We can merely discuss such infections as we have encountered from the standpoint of the organ system mainly involved. Consequently, we are unable to follow Hare and Fry into the "clinical intricacies" which they describe, and prefer to write simply of streptococcus infections of the genital tract in bitches and of the skin. Our desire is to support and in some measure amplify their observations.*

Genital Infections in Bitches

As Hare and Fry observed, these infections are of great economic importance to the breeder and our main object has been, as stated, to see if the loss can be alleviated; unfortunately, however, we have had little success. Our

* Owing to the war and to change of appointment it has been impossible to continue this work, and publication is delayed.

experience, which is similar in the main to that of Hare and Fry, may be given under the following headings.

Indications of Infection

(a) *In the bitch.*—A common indication is that the bitch, although whelping normally and herself remaining in apparently normal health, fails to rear part or the whole of the litter. As pointed out by Stafseth, Thompson and Neu (1937), this failure may be ascribed by the owner to some defect in the milk, e.g., so-called "acid milk," an opinion for which there seems to be no real foundation. The fact that pups are lost more frequently in the winter than in the summer months may appear to support the view that there is some dietary deficiency, but it is quite as likely that during the summer the mother's natural resistance is higher and for this reason she is less heavily infected.

Commonly, also, the bitch fails to conceive although mating is practised at the right time and is of normal duration. Or again, the bitch may show such signs of pregnancy as swelling of the abdomen but no pups are born. This peculiar state of affairs was reported to us from two kennels under conditions which made it very unlikely that the bitches had aborted. Abortion may, however, be an indication that the bitch is infected with streptococci.

Bitches have occasionally been reported to us as "out of sorts" under circumstances which suggest that slight fever, abnormal looseness of the bowels, and slight coughing are associated with the breeding troubles present in the kennels. This is quite in accordance with the observations of Hare and Fry (1938)[1] who regard mild symptoms of this nature as representing the initial illness. In one large kennel the owner reported the widespread existence, not only of the signs just noted, but also of troublesome skin eruptions and skin irritation among many of his animals; repeated attempts to demonstrate ectoparasites had failed. Whether this skin disease was connected with streptococcal infection cannot be said, though it would appear to be quite possible. As an example of what may occur in the breeding history of an infected bitch, the following is given as an illustration. All seven pups of the first litter died; at the second heat, service was missed; of the second litter of seven pups, six died; the fourth heat was allowed to pass; the six pups of the third litter died; the sixth heat was two months late and service was ineffective. Before and after the sixth heat she was given sulphanilamide.

Occasionally it seems that the disease may have malignant characters in that the bitches themselves die either a few days before whelping or immediately after ("puerperal form"). In a valuable St. Bernard bitch death took place within a week of whelping and hæmolytic streptococci were isolated from the lung and liver. There were 11 pups *in utero* and three of them were very carefully examined bacteriologically, pleural and peritoneal fluid and

material from the lung and spleen being sown in serum broth as well as in blood agar, but no hæmolytic streptococci could be isolated.

In four instances, where bitches had previously lost litters, some of the pups were removed to a foster mother. In the first case a litter of seven pups was reared thus for six weeks when at least three of them became sick and died. Two of them had areas of suppuration beneath the skin of the frontal region and the third had a suppurative pericarditis. From the pus in all three cases group G streptococci were isolated. The second bitch had lost two litters, and three of the pups from the third litter were removed "within a few hours of birth to a foster." The pups sucked well but died within a week and hæmolytic streptococci were isolated from the heart blood of two of the pups. In the third case hæmolytic streptococci were isolated from three pups dying 12 days after birth although they had been put on a foster mother. The fourth case was that of a Pekingese bitch, four to five years old, whose first two litters of five and four pups were raised normally. At the third whelping there was only one pup and this died at birth. The fourth litter of five was born normally and the pups were left with the mother for nearly 48 hours when they were removed to a cat foster-mother, owing to illness of the bitch. The bitch was feverish and had a reddish vaginal discharge, a swab of which showed enormous numbers of hæmolytic streptococci. Three days after whelping we took the opportunity to obtain milk with careful precautions against skin contamination. Altogether 0.4 c.c. was collected from six teats with a sterile pipette; by plating in blood agar hæmolytic streptococcus colonies developed in numbers estimated at 375 per c.c. The bitch was treated with sulphanilamide (0.5 gm. three times daily *per os* for two days) and then with red prontosil (5.0 c.c. twice daily intramuscularly for four days), the treatment being combined with uterine flushings with glycerin and water (Miss H. Neve, M.R.C.V.S.). The temperature gradually fell and by the tenth day the bitch appeared to be in normal health; no mastitis had developed but vaginal swabs taken six days after whelping still showed streptococci. In this case all the pups survived, except one, which was said to have been crushed by the foster-mother.

In a foxhound kennel it was reported that the bitches had been aborting, generally at about the sixth or seventh week of pregnancy. We were able to examine vaginal swabs of four recent cases and from two of these which had aborted four days and six weeks previously hæmolytic streptococci of group G were isolated.

Three cases of mastitis have been examined. From the udder secretion hæmolytic streptococci were isolated, in two cases belonging to group G and in the other case typing was not attempted. Two of these were acute and fatal, while the third case was benign and apparently associated with the ordinary kind of genital infection.

There has been an opportunity to make a post-mortem examination on

three bitches. In these instances there were no gross signs of infection in the genital tract. From two of these cases, both of which died after whelping, hæmolytic streptococci were isolated from the uterus. It seems that the hæmolytic streptococcus when in pure culture does not cause a pyometra. In six cases of pyometra, however, examined by our colleague, Mr. D. L. Hughes, mixed infections of coliform organisms and hæmolytic streptococci were found.

(b) *In the pups.*—Pups may die within the first week of life or not until they are three to six weeks old. They are born normally and in the first instance appear to thrive for some two to five days, after which they stop sucking, become cold and die at any time up to a week or so. Prior to death, reddish or purple spots may appear on the skin of the abdomen and the navel looks unhealthy. In the second kind of case the pups remain apparently normal for a month or so, when one or more of the litter may be seen to go "off colour" and die a day or two later after showing slight signs of respiratory distress. On post-mortem examination parts of the lungs may be consolidated and there may be much clear fluid in the pleural cavities. In our experience it has been easy by blood agar plating to isolate hæmolytic streptococci from the pleural exudate, but one may fail to do so from the blood or the lung tissue. Out of 36 dead pups in which the conditions for a bacteriological examination could be considered satisfactory 15 were positive for hæmolytic streptococci.

Spread of the Disease

The evidence to be offered on this point is circumstantial and not extensive. It is obvious that infected bitches are acting as carriers, and we have encountered bitches in apparently quite good health whose vaginal swabs yielded hæmolytic streptococci for months. The suggestion is that female pups which survive become carriers of infection, but we know of only one case which seems to bear this out. The male dog may be instrumental in maintaining infection in the sense that he can transmit the disease venereally, since in a few instances preputial swabs have been positive for hæmolytic streptococci. These organisms have also been isolated from the tonsils of male dogs—and also quite often from the tonsils of bitches. There is an obvious possibility that the throat of a male may become infected from the vaginal secretions of the bitch.

In one case milk was taken from six teats of an infected sheepdog, the secretion from each teat being plated separately in blood agar, but staphylococci only were found. A portion of each milk sample was also cultivated in serum glucose broth but streptococci were not grown. This bitch had whelped six pups two days previously and all of them died. In another case, however—a Pekingese bitch, referred to above—we were able to show quite definitely that the streptococci can be excreted with the milk.

XUM

Prevalence of the Disease

During the past two years we have encountered the disease among dogs belonging to 16 owners and sometimes in large kennels, affecting breeds as diverse as Sealyhams, Pekingese, English Terriers, Dachshunds, Old English Sheepdogs, Foxhounds, Spaniels, Bulldogs, Poodles and St. Bernards. Altogether we have knowledge of upwards of 60 cases in adult dogs.

In a high-class Sealyham kennel with a bitch population of about 40, 19 bitches were proved to be infected and the owner stated that he had lost 180 pups in five years. In addition, many of his animals had missed service, although 12 different sires had been used. Naturally the owner's financial losses had been enormous.

In a Foxhound kennel also the losses were particularly severe. Not only had there been loss of pups, but some of the bitches also had died. In May, 1939, vaginal swabs were taken from all the bitches, 33 in number, and rather to our surprise every one was excreting hæmolytic streptococci.

In a well-run Pekingese kennel of 15 bitches and seven dogs vaginal or preputial swabs revealed that eight of the former and three of the latter were infected. Swabs could be taken from the animals in this kennel on one occasion only. The owner stated that there had been no breeding trouble "apart from what we regard as a normal small proportion of sterility or deaths among pups." A more precise statement than this was not available, though it seems evident the trouble had not been serious. Of the bitches, ten were maidens and four of them gave positive swabs; of the remaining five, four of which had had one litter and one three litters, four were affected. One of the dogs which gave a positive swab had "a reputation for sireing weakly and small litters, some of which had died."

Diagnosis

A clinical history of deaths among pups shortly after birth, although the mother appears to be in more or less normal health, is suggestive of streptococcus infection. The diagnosis in any particular case is rendered still more probable if the disease has been proved by bacteriological examination to exist in the kennel. The only way by which a definite diagnosis can be reached, however, is by the isolation of hæmolytic streptococci from vaginal swabs or from the dead offspring. While a positive vaginal swab is conclusive evidence of infection, we do not place quite as much reliance on a negative result. In this connection, one important point is that swabs should be properly taken. Since this operation is not so simple as might be thought we would quote the following paragraph from the article by Hare and Fry: "In taking a vaginal swab we suggest that an assistant should restrain the patient, one hand at the neck, the other erecting the tail. The operator should clip away the hairs

about the vulva, and by means of a tampon of cotton wool soaked in alcohol he should thoroughly cleanse the exterior of the vulva. With a fresh spirit-soaked tampon of wool he should gently wipe the inside of the vulva up to and including the urethral opening. With the thumb and first two fingers of his left hand he should evert the lips of the vulva until the urethral opening is evident, then with the right hand he should pass the swab up some three or four inches to the *cervix uteri*. By retaining the hold of the vulva with his left hand he will avoid touching the outer lips of the vulva with the swab during its withdrawal." To this description we could add that the clipping of hairs from the vulva requires the greatest care to avoid injuring the delicate skin; that the cleaning of the external genitals must be thorough, using alcohol or soap and water, followed by drying the interior of the vulva with cotton wool; and that in the cleaning process disinfectants other than alcohol must be avoided. Unless this cleaning process is properly done, bacteriological examination is rendered difficult owing to fæcal contaminants. Care is required in passing the swab and it demands a gentle to-and-fro and twisting movement. The operation in maiden bitches and in some others is particularly difficult and a good way of getting over this (suggested by the Chief Laboratory Assistant, Mr. A. E. Mundy) is to pass well up into the vagina the thick end of a clean clinical thermometer. The passage of the swab is then greatly assisted by the smooth surface of the thermometer; when the swab is in position the thermometer can be withdrawn and the mucous membrane in the neighbourhood of the cervix gently wiped. It appears to be quite safe to swab the vaginæ of pregnant bitches so long as the operator is careful. The swabs issued by us are fixed to nickel silver wire, inserted into an indiarubber bung, the wool being kept moist with a few drops of sterile broth.

As soon as the swab is received in the laboratory, about one c.c. sterile broth is added to the tube and in this fluid the swab is well rinsed. The rinsings are sown out in (ox) blood agar, using pour plates and generally in a series of three. Half of the rinsings are put in the first plate and two further dilutions are prepared in saline at 1 in 5 and 1 in 50, about 0.5 c.c. being plated each time. After 24 hours at 37 deg. C. the presence of hæmolytic streptococci is shown by minute colonies with clear zones of lysis up to 2 mm. or so in diameter. When few in number, their recognition may be difficult owing to the presence of many contaminants. Prominent among the normal organisms of the vagina are stapylococci, deep colonies of which in ox blood agar are surrounded by zones up to about 8 mm. in diameter in which the blood is darkened.

A similar technique is used in the examination of dead pups from which, if possible, pleural exudate is plated. If there is no pleural exudate a piece of lung tissue is ground up and plated.

XUM

Therapeutic Treatment

For the treatment of carrier bitches sulphanilamide and M & B 693 have been tried, in both cases unfortunately without succcess. Both drugs have been used at the rate of 1.0 gram per ten pounds body weight daily for ten days, the daily amount being divided into four equal portions and given by the mouth at four-hourly intervals during the daytime. At this dosage the drugs are well tolerated and might be expected—as we have been informed by Dr. Stableforth—to give good levels of concentration in the blood.

Altogether sulphanilamide was tried on 13 infected bitches and in six of these a second course was given after an interval of a month or so. In some cases streptococci could not be found in the vagina for a few days after treatment, but they then reappeared in large numbers. In one case at least the bitch subsequently lost litters and streptococci were isolated from some of the pups.

M & B 693 was given by the mouth to two Pekingese bitches belonging to the same kennel; in one of these ("Fairy," a maiden bitch and daughter of "Curly" which was also a carrier) the course was repeated one month later; in the other ("Anne") for the second course (carried out two months later) a sodium salt of the drug was used—at the rate of 0.25 gram daily for ten days, the daily dose being divided into four parts and given intramuscularly at four-hourly intervals. "Anne" had previously received two courses of sulphanilamide at a month's interval; after her fourth course of drug treatment she was mated and thought to be pregnant, but no pups were born. "Anne" had previously had five litters, with 13 pups in all, and in four of the litters some of the pups had died.

Control of the Disease

In the absence so far of favourable results from therapeutic treatment, it may be useful to speculate upon measures for controlling the disease. In the first place, it may be said that we have only used two drugs of the sulphanilamide class and it may well be that among the many similar preparations now being synthesised some that are effectual for the present purpose will be found. Another line that might be explored is the combination of specific immunisation with drug therapy. Lowenthal (1939) has shown in the case of mice that, while a single dose of sulphanilamide given at the time of infection will protect only a minority of the animals, similar treatment with the drug will protect the majority of the animals if 18 hours before infection they had been given a dose of specific serum. The serum alone was incapable of preventing death. Unfortunately, L. Colebrook and Maxted (1940), using four strains of hæmolytic streptococci of different serological type and of high mouse virulence, have been unable to confirm Lowenthal's striking results. The authors also point out the difficulties of applying in practice the serum +

drug treatment to man, and no doubt similar difficulties would be encountered in animals.

Further research is also required as to the best time to intervene with drug therapy in these streptococcus infections in dogs. In the cases we have tried the disease has been in what may be called the quiescent state. Possibly over the puerperal period the disease may become active and the streptococci more amenable to the effects of sulphanilamides. Treatment with these drugs over, say, five days prior to whelping and continued for five days or so thereafter may be found to give better results than can be obtained at any other time. Indeed, we are informed by Mr. V. Berwyn Jones and Mr. J. S. Sweeny, M.R.C.V.S., that they have lately practised this and apparently with good results. Finally, the real solution of the problem may be to dose the pups, beginning, say, 24 hours after birth.

At present and until knowledge on the above points is available, one is forced to think that bitches should not be introduced to breeding kennels or used for breeding unless, say, two vaginal swabs taken at a few weeks' interval have given negative results. We believe that veterinary surgeons who give this advice, subject to the qualification that negative swabs are not an absolute guarantee that the bitch is healthy, will be acting in the best interests of their clients.

If the owner decides to breed from infected bitches, it is possible that the pups can be saved by removing them to a foster mother as quickly as possible after birth. We have two cases which perhaps give some support to this suggestion. One is the case of the Pekingese bitch described above, in which streptococci were found in the milk. In the second case the bitch died after whelping and she was subsequently found to be infected, while pups which had to be brought up on a foster mother survived. There are, on the other hand, instances where removal of the pups has failed to save their lives.

Dermatitis and Other Non-Genital Infections

Six dogs suffering from chronic suppurative dermatitis and three with interdigital cysts have been examined; from five of the former and the three with cysts hæmolytic streptococci were isolated. From several of these eight positive cases streptococci were not isolated at the first trial, but only staphylococci; also in one of the interdigital cyst cases streptococci were grown from one previously unopened cyst but not from another. We think it quite likely that in many cases of chronic dermatitis in dogs ascribed to staphylococci a more frequent or more intensive examination would have indicated hæmolytic streptococci as the true cause.

In four of the dermatitis cases the lesions were mainly located about the face, and in the other two on the back and about the hind legs. The site of the lesions seems to suggest that the infection is primarily one of the nose or

XUM

throat and is distributed to accessible parts of the skin by licking or biting. On the other hand, it is possible, of course, that the lesions on the body surface are introduced by way of the blood stream.

One of the most persistent cases of dermatitis was in an English Setter bitch, hæmolytic streptococci being found on several occasions, not only in the skin lesions, but also in very large numbers in the vagina. This bitch had had one litter of seven pups two years previously, and of these five had died when four weeks old, due, so it was supposed, to worm parasites. This animal was treated with a full course of sulphanilamide by the mouth and later with the M & B 693 sodium preparation intramuscularly, but it cannot be said that treatment was successful and in spite of most assiduous effort the bitch finally had to be destroyed. A second case of dermatitis in an Alsatian improved under surgical treatment (Mr. G. C. Knight, M.R.C.V.S.) combined with M & B 693 by the mouth. Streptococci were also isolated from the prepuce of this dog. A third case failed to respond to operative treatment and prontosil. One case showed marked improvement from operative treatment (Mr. J. W. H. Holmes, M.R.C.V.S.) and staphylococcus toxoid. One of the interdigital cyst cases responded to drastic surgical treatment (Mr. Holmes); in the other, treatment was more superficial and the case showed no permanent improvement.

An owner of a large kennel of English Setters reported upon an epidemic of "throat abscesses"—the "adenitis syndrome" of Hare and Fry (1938). These abscesses were benign in the sense that there was little or no disturbance in general health and after the abscesses had been opened healing was rapid. From the pus of one of these group G streptococci were isolated.

Discussion

One point to be considered in connection with these genital infections is the specificity of the streptococci that can often be isolated. While from general considerations we see little room for doubt that the streptococci are responsible, we have considered it necessary to examine swabs from a number of normal breeding animals, both male and female. For this purpose swabs have been taken from bitches and from the prepuce (actually from the surface of the exposed penis) of several dogs. As was to be expected in view of the known facts regarding streptococcus infections in man, this work has not been plain sailing, and from a number of "normal" animals hæmolytic streptococci have been isolated. However, a number of bitches presented by the owners as "normal," because they had at one time or another reared litters, were really abnormal, some of them, for example, having shown delayed œstrus. From vaginal swabs of some of these we have isolated hæmolytic streptococci, but from others where from the history the bitches would undoubtedly be classed as normal, hæmolytic streptococci could not be isolated.

Another point concerns the serological typing of these streptococci. Dr. Stableforth has examined on our behalf 33 strains of hæmolytic streptococci isolated in the course of this work; of these 28 belonged to G and five were group C. So far as the relationship of the various clinical conditions with one another is concerned, the group G strains were isolated from vaginal swabs of 17 bitches, from one pup, and the remaining ten from the tonsil (one), throat abscess (one), skin (three), pedal cyst (two), prepuce (one) and mastitis (two). The fact that so many strains associated with and presumably responsible for the various clinical conditions belong to one serological group suggests that it is proper to speak of one streptococcus infection, the clinical manifestations of which are varied. Here again an analogy may be found in the streptococcus infections of man. There is still, however, the possibility that within the one group particular types are associated with particular localisations, that, for instance, a strain from the genital organs on transfer to a new host, while it *might* produce pedal cysts, would be more likely to set up genital disease.

As to the actual way in which the pups become infected, there are several possibilities, and we do not pretend to have cleared the situation. The offspring may become infected *in utero,* during their passage through the genital tract at the time of whelping, by way of the milk, or through being licked by the mother. We have not been able to obtain evidence that pups are infected before birth or through the milk, though much further investigation is required on these points, and at the moment we favour the theory of infection during or after birth in the ways indicated. More careful observation is also required as to the rearing of pups on foster mothers, though it seems rather obvious that as a method of prevention this may not be of great practical importance.

Finally, there is the question of treatment. In non-pregnant and in a few pregnant bitches we have been unsuccessful with full courses of sulphanilamide and in the few cases tried with M & B 693. Boddie (1939) also reports that in two outbreaks of disease in Great Danes associated with hæmolytic streptococci, sulphanilamides were found to be of no value. It must be remembered, however, that chronic infections in general respond far less well to chemotherapy than severe infections of more acute character. It was thought that as sulphanilamide proved ineffective, M & B 693 might succeed, especially as this drug has a wider range of activity and is of lower toxicity. The reason for the failure of these drugs is not yet known, but there is more than one possibility. The chance that the drugs are not active against these streptococci seems unlikely since Dr. Stableforth (private communication) has found in experiments with mice that "sulphanilamide protected against 100 to 1,000 average lethal doses of several strains of group G streptococci which had been made highly virulent by passage in these animals." As to dosage, it should be noted that the amount used was at the rate of 1.0 gram per ten

XUM

pounds body weight, an amount twice that usually employed in man. It may also be that streptococci located in relatively avascular areas are shut off from effective action by the drug. There is also, of course, the possibility that the drug was not absorbed from the alimentary tract in quantities sufficient to give adequate concentration in the body, but from Stableforth's observations this hardly seems likely. Messrs. May and Baker kindly suggested that better results might be obtained with a soluble sodium derivative of M & B 693—a product which is more active though at the same time more toxic than M & B 693 itself—the drug to be given by deep intramuscular injection. This was carried out on two cases, again without permanent effect, while observations on the blood concentration by Mr. S. L. Hignett indicated no difference in this respect between giving the sodium salt intramuscularly and M & B 693 *per os.*

Summary

1. Observations are recorded on the infection of dogs with hæmolytic streptococci, with particular reference to genital infections in bitches and ensuing mortality in pups.
   The widespread nature of the disease in some breeding kennels and the losses occasioned thereby are emphasised.
   The organisms may be present not only in the vagina but also in the milk of the bitch, and they may also be harboured in the prepuce of the male and in the tonsils.
2. Most of the streptococci isolated belonged to Lancefield's serological group G, a few to group C.
3. Treatment of bitches carrying the organisms in their genital passages and of dogs with skin affections due to hæmolytic streptococci, using full doses of sulphanilamide and M & B 693, was unsuccessful. There is no reason, however, why efforts at specific drug treatment should not be continued.
4. Suggestions are made as to the detection of carriers and control of the disease.

Acknowledgments

We have pleasure in acknowledging the kindness of Messrs. Bayers and Messrs. May and Baker in providing free gifts of sulphanilamide and M & B 693 respectively and for advice as to same. We also express our thanks to Dr. A. W. Stableforth and Mr. S. L. Hignett for laboratory help and to the various clinical workers mentioned in the paper, and also to Misses R. Teverson and J. O. Joshua, M.R.C.V.S., all of whom assisted us on the hospital side.

REFERENCES.

Boddie, G. F. (1939): *Vet. Rec., 51,* 1237.
Colebrook, L., and Maxted, W. R. (1940): *Lancet,* i, 21.
Hare, T., and Fry, R. M. (1938): *Vet. Rec., 50,* 213.

Hare, T., and Fry, R. M. (1938)[1]: *Vet. Rec., 50,* 1537.
Loewenthal, H. (1939): *Lancet,* i, 197.
Pilot, I., Buck, C., Davis, D. J., and Eastman, D. A. (1936): *Proc. Soc. Exp. Biol. & Med., 34,* 499.
Stableforth, A. W. (1938): *Vet. Rec., 50,* 1203.
Stafseth, H. J. (1940): *J. Amer. Vet. Med. Assoc., 96,* 230.
Stafseth, H. J., Thompson, W. W., and Neu, L. (1937): *J. Amer. Vet. Med. Assoc., 90,* 769.

A DISEASE OF CHICKENS APPARENTLY IDENTICAL WITH NUTRITIONAL ENCEPHALOMALACIA

By F. D. ASPLIN, M.R.C.V.S., Dip. Bact.
Institute of Animal Pathology, University of Cambridge.

Introduction

PAPPENHEIMER and Goettosch[1] have described a severe disease of young chickens which was produced experimentally by feeding a mash composed of dried skim milk, casein, maize starch, yeast, lard, paper pulp and a salt mixture, i.e., Pappenheimer Diet, 108. The symptoms were those of ataxia, rapidly progressing to complete prostration and death. On post-mortem examination lesions were confined to the central nervous system. The cerebellum was most frequently involved and the cerebrum and medulla less often. The condition was essentially one of ischæmic necrosis. To this condition they applied the name Nutritional Encephalomalacia. Dunlap[2] encountered an ataxia of chicks which was associated with nephritis. No other lesion could be demonstrated, but the symptoms appear to resemble closely those of Pappenheimer's disease. The condition of the chickens' brains was not recorded. The disease was first seen by Dunlap in 1928, but was reported as causing quite heavy losses in 1927. Poultrymen have given the name "Crazy Chicks" to affected birds.

The first description of a natural disease having exactly similar symptoms and lesions as nutritional encephalomalacia was given by Jungherr,[3] who recognised the condition in 40 specimen consignments.

An apparently identical disease has been recognised in three groups of chickens at Cambridge. The incidence was low; only six birds out of a total of 112 were affected. There was no contact between the three groups and the food was different in each case. The age of affected chickens varied between three and five weeks.

Differential diagnosis of the nervous diseases of birds is becoming of increasing importance. This condition of encephalomalacia is one which should be considered when young birds exhibiting symptoms of ataxia are received for examination.

Poultry farmers sometimes speak of "fits" in chickens. It seems probable that some of these may be affected with encephalomalacia.

Symptoms

The symptoms were of extremely sudden onset, and in two cases were followed by death within 24 hours. The remainder were etherised when ataxia was well advanced. The affected chickens were amongst the best grown of their respective groups. The earliest indication of the development of symptoms was shown by the chicken flapping its wings to aid it in running. This was quickly followed by a loss of equilibrium. When standing, the bird makes conscious attempts to balance. Soon it is no longer able to stand and it goes down on its side and paddles its legs. The neck may be retracted and arched over its back. Attempts to make the bird stand are unsuccessful. As soon as support is removed it usually pushes itself over backwards and then flutters about on its side for a moment. Even when unable to stand it will make vigorous attempts to get to the food trough.

Pathology

No bacterial growth has been obtained when blood, brain and liver have been inoculated on ordinary laboratory media. Transmissibility by animal inoculation has not been studied.

The most marked and obvious lesion consists of œdema and hæmorrhage of the cerebellum. When a plaque of bone was removed and the superior surface of the brain exposed, the cerebellum was noted to be swollen and watery in appearance. The surface of the convolutions was intensely congested and marked by small hæmorrhages. A sagittal section of the head showed that the cerebellum appeared to have "pushed" forward between the two lobes of the cerebrum and appeared to occupy the greater part of the cranial cavity. The exposed cut surface of the cerebellum was marked by petechial hæmorrhages and the normal arborescent appearance was less distinct. The cerebellum was of a soft and mushy consistency.

Microscopic Lesions

The microscopic appearance resembles exactly that of nutritional encephalomalacia as described by Wolf and Pappenheimer.[4] By holding a stained section to the light, pale areas of necrosis can be recognised by the unaided eye. The lesion may involve the greater part of the brain or be restricted to a small area of a single cerebellar convolution. It is remarkable that whilst one convolution may be completely necrotic the neighbouring one may remain apparently normal. Œdema resulting in a separation of the cells and fibres is a constant feature. The œdema is most obvious at the junction of the molecular and granular layers, producing a spongy reticular appearance. The nerve cells, particularly the Purkinje cells and the small cells of the granular layer, can be seen to be undergoing degenerative changes. Small hæmorrhages appear in all layers of the cerebrum, but they are most obvious in the Purkinje cell zone. Capillary thrombi having a hyaline appearance are numerous. In one case an extensive area of necrosis was present in the cerebrum.

Etiology of Experimental Nutritional Encephalomalacia

In view of the similarity of the disease described with experimental nutritional encephalomalacia, a discussion of the etiology of that condition is of interest. Pappenheimer, Goettosch and Jungherr[8] could obtain no evidence indicating the infectious nature of the condition nor could intestinal toxins be incriminated.

The inclusion of certain natural foodstuffs—cereals and cereal products, green foods and animal products—in the simplified diet, Pappenheimer 108, afforded some slight protection. The protective factor was found to be present in certain vegetable oils, e.g., maize oil, cotton-seed oil, peanut oil, Soya bean oil.[5, 6]

Dam, Glavind, Bernth and Hagens[7] have reported that complete protection has been afforded to chickens kept on Pappenheimer Diet 108 when the birds have been dosed with synthetical *a* tocopherol (vitamin E). Pappenheimer,[8] using *a* tocopherol of vegetable origin, has confirmed this finding. In a field trial the addition of 5 per cent. soya bean oil to a commercial mash did not result in protection.

It is difficult to understand how the usual poultry foods can be deficient in vitamin E. It is well recognised that vitamin E is unstable in the presence of oxidising fat. This may afford an explanation to the apparent contradiction of Pappenheimer's results.

Ni[9] considered that the amino acids of the protein of Diet 108 were unbalanced and that protection could be obtained by the addition of gelatine.

XUM

In figures presented, Chinese gelatine (Ah-chiao) seemed to have some protective value. Further work[10] indicated that the factor was present in hydrolysed ether-extracted Ah-chiao, but was not present in the oily extract of Ah-chiao. The number of birds used by Ni was small and the statistical significance of the results is doubtful.

Norris[11] favours the hypothesis that encephalomalacia is caused by the development of rancidity in the fat of the diet and that the injurious effect occurs during digestion or even later. In support of this contention he reports that Bauernfeind, Hodson and Norris* have noted a decrease in the incidence of encephalomalacia when an antioxidant, *a* naphthol, was incorporated in the lard of Pappenheimer Diet 108. A similar decrease was also noted when soya bean oil was fed independently of, but simultaneously with, this diet.

Russell, Taylor and Polskin (1940) fed to chickens a mash which had been extracted with ether so that the fat content was reduced to 1 per cent. or less. Provision was made for a supply of vitamins A and D, free of fat. Assuming that the extraction process removed the vitamin E, the authors conclude that vitamin E was not necessary for growth.

In view of the imperfect understanding of the cause of the condition, recommendations for control must be of a general nature. Food should always be freshly mixed. If the incidence is becoming serious, a complete change of food would be justified.

Summary

The occurrence of a severe nervous disease in young chickens is described. This disease is characterised by ataxia, forced movements, prostration and death. On post-mortem examination œdema, hæmorrhages and necrosis were noted in the cerebellum. This disease is probably identical with experimental nutritional encephalomalacia.

REFERENCES.

(1) Pappenheimer, A. M., and Goettosch, M. (1931): *J. Exp. Med., 53,* 11.
(2) Dunlap, G. L. (1932): *J. Amer. Vet. Med. Ass., 80,* 880.
(3) Jungherr, E. (1936): *Science, 84,* 559.
(4) Wolf, A., and Pappenheimer, A. M. (1931): *J. Exp. Med., 54,* 399.
(5) Pappenheimer, A. M., and Goettosch, M. (1934): *Proc. Soc. Exp. Biol. & Med., 31,* 777.
(6) Goettosch, M., and Pappenheimer, A. M. (1936): *J. Biol. Chem., 114,* 673.
(7) Dam, D., Glavind, J., Bernth, O., and Hagens, E. (1938): *Nature, 142,* No. 3609, 1157.
(8) Pappenheimer, A. M., Goettosch, M., and Jungherr, E. (1939): *Storrs Agri. Exp. Stat. Bul.,* 229.
(9) Ni, T. G. (1937): *Chinese J. Physiol., 12,* 281.
(10) Ni, T. G. (1938): *Ibid., 13,* 229.
(11) Norris, L. C. (1940): *Poul. Sci., 19,* 100.
(12) Russell, W. C., Taylor, M. W., and Polskin, L. J. (1940): *Jour. Nutrit., 19,* 555.

* Unpublished results.

FIG. 1.—Affected Chicks.

FIG. 2.—Cerebellum. Extensive œdema and degeneration. The convolution on the left is not involved. X 100.

XUM

Clinical Articles

FIBROMA OF THE BLADDER IN A BITCH

By G. H. ARTHUR, B.V.Sc., M.R.C.V.S.
University of Liverpool.

Subject.—A five-year-old cross-bred Airedale bitch, weighing 35 lb.

History.—The owner had noticed abnormal frequency of micturition with hæmaturia for several weeks before presenting the animal for examination.

Symptoms.—The patient was in fair condition but appeared listless and the appetite was poor. The conjunctival vessels were congested and the pulse lacked tone. The temperature was normal.

Abdominal and rectal palpation disclosed a firm swelling in the position normally occupied by the bladder. Digital pressure on the swelling was resented. A metal catheter was passed and abutted against a firm object, but there was no crepitation as occurs with a vesical calculus. About half an ounce of almost unaltered blood was withdrawn from the bladder.

Exploratory laparo-cystotomy was decided on, and proceeded with, after making the usual pre-operative preparations.

Operation.—The bitch was anæsthetised by the intravenous injection of Nembutal gr. 5.2.

The abdomen was opened by a para-median incision from a point just in front of the pubis, forwards for a distance of 2½ inches. The bladder was withdrawn, turned backwards, and after clothing it in swabs, the viscus was incised for a distance of 1½ inches along its dorsal wall between two of its very congested vessels. A small quantity of blood flowed through the incision, and the interior of the bladder was now seen to be occupied by a tumour-like mass. One was able to pass a probe all around between the tumour and the closely apposed wall of the bladder, except at a point near one lip of the incision, where the tumour was pedunculated. By gentle traction with a Vulsellum forceps the tumour, which was as large as a hen's egg, was brought out through the bladder incision. A transfixing ligature of No. 2 catgut was placed through the peduncle as near to the mucosa of the bladder as possible, and the stalk was then divided. The bladder was irrigated with sterile water, swabbed out, and after closing the incision with interrupted Czerny sutures of No. 00 catgut, omentopexia was performed. The internal sheath of the rectus muscle was closed with a continuous suture of No. 0 catgut and the external sheath and subcutis were closed in two layers with No. 2 catgut. The skin was approximated by Halstead sutures of No. 1 silkworm gut.

XUM

The bitch made a rapid and uneventful recovery, the sutures being removed on the eighth day. Up to the time of writing (seven weeks after operation) there has been no evidence of recurrence of the tumour and the animal has increased in weight by 6½ lb.

Professor Craig examined the tumour and reported that it was a fibroma.

AMPUTATION OF THE TEAT IN CATTLE

By C. WENTWORTH ELAM, M.R.C.V.S., D.V.H.
Liverpool University Veterinary School.

MANY practitioners number among their clients those who request them to remove a portion of a cow's teat. This request is made when the owner finds that in spite of his own treatment for "Garget," he is convinced that the cow will "lose a quarter."

These clients will not permit of any other form of treatment being adopted for they are of the opinion that, although some deformity will remain as a result of the operation, it is the best and most economical form of treatment.

They state that this simple operation gives immediate relief to the patient, lessens the period of illness, ensures proper drainage of the affected quarter, and saves the expense incurred by repeated visits made by the veterinary surgeon. Moreover, within a short period of time it will be found that the three remaining healthy quarters are secreting practically the same amount of milk as was previously being secreted by the four healthy quarters.

As regards the operation, the surgeon has to consider the following points:

(1) *The Question of Restraint.*—It is for the surgeon to decide whether the animal should be cast and a general anæsthetic administered, but the operation can be performed with little inconvenience without casting. If the cow is in a double stall its neighbour should be removed. A "bulldog" should be applied to the septum nasi of the patient while the hind legs are restrained by means of an Alfa-Laval cow leg chain. During the operation the patient remains tethered in the standing.

(2) *The Operation.*—The operation area should be prepared in the usual manner and the teat encircled well above the site of the obstruction with 1 in. wide strong sterile tape. The tape is applied to control hæmorrhage and should be tied tightly. As regards the question of local anæsthesia, an ethyl chloride spray will be found most useful, for the teat is a very sensitive structure and the cow strongly resents the insertion of a hypodermic needle several times into the region to be operated upon. Moreover, the tissues of the teat will not permit of easy diffusion of a local anæsthetic. When the part has been

prepared and anæsthetised the teat is grasped firmly above the tape with the left hand and the desired portion of teat severed as quickly as possible, ½ in. below the ligature. If a sterile safety blade is used it is rarely necessary to make more than two rapid "cuts" to sever the teat, while the cow will show little, if any, pain. By using a safety blade there is no risk to the operator from a "flying" scalpel; moreover, since a scalpel is thicker than a safety blade and is often triangular on section, the incision made by the blade is more rapid and rarely accompanied by pain. When the teat has been severed a large receptacle containing some antiseptic is held below the teat to collect the purulent discharge when it escapes. The tape ligature is now loosened slightly so that the purulent secretion can escape from the quarter into a receptacle. The quarter is then irrigated with a suitable antiseptic by the aid of a Higginson's syringe. When the quarter has been irrigated the tape is then tied firmly until hæmorrhage has been completely controlled. It may be necessary to apply an additional tape ligature to control the hæmorrhage completely. When the surgeon is satisfied that hæmorrhage has ceased he instructs his client to loosen slowly the ligature in five or six hours. The ligature can be removed then if there is no hæmorrhage, otherwise it should be reapplied and tied lightly for a few hours longer. The after-treatment consists of irrigating the quarter twice daily with an antiseptic solution, applying antiseptic oil to the stump of the teat and covering it with a special rubber cap.

Abstracts

PRENATAL AND POSTNATAL SEX RATIO IN SHEEP*

By WILLIAM LEWIS HENNING

Professor of animal husbandry, Pennsylvania Agricultural Experiment Station

Introduction

MODERN evidence indicates that the sex chromosome from the male gamete is the initial determiner of sex in mammals. A necessary implication of this mechanism is that sex of a zygote is determined at fertilisation. Cytological studies indicate that the male gametes bearing, respectively, the X and the Y chromosome are produced in equal numbers. Unless factors other than chance

* Reprinted from *Journal of Agricultural Research*, Vol. 58, No. 8, Washington, D.C.

interfere, the sex ratio at fertilisation should accordingly be one of equality. In the absence of sex reversal, later change can come about in the ratio between the sexes only as the result of a differential mortality.

Sex ratios (percentages of males) may be ascertained at different stages in the life history of a population. In mammals, it is convenient to consider three separate stages: at conception, birth, and maturity. Sex ratios at these stages are usually spoken of as primary, secondary, and tertiary, respectively.

The true primary sex ratio might conceivably be obtained by a cytological study of a large number of fertilised eggs. The ratio would depend upon the proportion of ova fertilised by the male- and female-determining spermatozoa, respectively. However, adequate numbers of fertilised mammalian eggs for such a study, in which the cytological picture could be determined, would be difficult to obtain. It is also impracticable to make sex determinations on a sufficiently large number of embryos before external differentiation of the genitalia. The immense labour involved precludes the histological examination of the gonads of any large number of embryos as a laboratory method. Actually, therefore, primary sex ratios have not been determined, but an approach is made by a study of the percentage of males in fetal life. This method of approach, then, will give the sex ratio as early in prenatal life as the sexes can be determined macroscopically. It leaves the very early stages as a matter of speculation.

Sex ratios at birth in most mammals have been found to approach equality. In contrast to this, however, several studies of fetal sex ratios have indicated a preponderance of males before birth. In some cases this percentage has been reported as being high in early fetal stages and showing a gradual decline toward birth. Such a trend would indicate a higher proportion of males at conception than at any other time in the life cycle. Most authors have assumed that with a high primary sex ratio, differential prenatal mortality tends to equalise the sexes by the time of birth. The only adequate data which give no evidence of difference between the prenatal and secondary sex ratios are those of MacDowell and Lord (*17*)[2] on the sex ratio of litters in the mouse.

The tertiary sex ratio is commonly applied to animals in the wild state where there are few artificial factors causing a differential mortality from birth to maturity. The tertiary sex ratio in domestic animals has little biological meaning because of the polygamous use of breeding males and the elimination of many males before they reach maturity.

The present paper reports the results of a study made on the prenatal and postnatal sex ratio in sheep.

If there is a differential mortality with respect to sex during the intrauterine period it should be reflected as a difference in sex ratios between dead and living fetuses. A summary of the sex ratio in relation to mortality is presented in Table 10. The data are analysed with reference to number of corpora lutea and number of live or dead fetuses. While the actual ratios

obtained differ considerably, in no cases are their differences significant. There is, therefore, no evidence in this study for a differential intra-uterine mortality with respect to sex. This is further substantiated if only those cases are taken in which the number of corpora lutea corresponds exactly with the number of live fetuses found, and which, if the evidence is accepted, indicate no previous prenatal mortality whatever. The ratio for 575 such fetuses is 51.5±2.08. These data are similar to those of MacDowell and Lord except that all of their sex records were at birth while these are at various stages and consequently do not exclude the possibility that there might have been some later mortality if gestation had not been terminated.

TABLE 10.—*Sex ratio in relation to sheep-fetus mortality.*

Corpora lutea (number)	Fetuses found in uteri	Fetuses *Number*	Males *Number*	*Per cent.*
1	1 live	415	212	51.1± 2.45
1	1 dead	16	7	43.8±12.40
2	2 live	160	84	52.5± 3.95
2	1 live	57	33	57.9± 6.54
2	1 or 2 dead	6	4	66.7±19.20
Live fetuses where—				
Number of corpora lutea equal number of fetuses		575	296	51.5± 2.08
Number of corpora lutea is greater than number of live fetuses		57	33	57.9± 6.54
Dead fetuses, sex determinable		22	11	50.0±10.70

Multiple Births—Frequency of Sex Combinations

A study of the sex combinations in twins may be used to estimate the frequency of monozygotic twinning. In material in which no monozygotic twinning occurs and in which the sex ratio is equal, the ratios of the three possible sex combinations would be expected to approximate 1 ♂ ♂ : 2 ♂ ♀ : 1 ♀ ♀, within the limits of error of random sampling and with the provision that these ratios are not materially changed by selective prenatal mortality. Monozygotic twinning should raise the proportion of like-sexed twins. Only limited data are available on the frequency of the different sex combinations in multiple births in sheep. Both R. T. Clark and Johansson, who have investigated the problem, conclude that monozygotic twinning is at most a comparatively rare phenomenon in sheep.

Totals of lambing records at the Pennsylvania Station over a period of 15 years, excluding the Southdowns, gave 122 ♂ ♂ : 214 ♂ ♀ :

Discussion

The normal secondary sex ratio (proportion of males at birth) in mammals appears in most cases for which adequate data are available

to be remarkably close to 50 per cent. In those species for which it is best established it varies less than 2 per cent. from equality. The mule is not a species, and the ratio for the cat is based on embryos.) This would appear to be the natural consequence of a system of alternative sex determination based on equal numbers of unlike male gametes, providing fertilisation is a random matter and differential mortality of the sexes from fertilisation to parturition is slight. Under such an interpretation it might be assumed that the deviation from equality at any time during fetal life would be less than at birth. If the deviation were greater in one direction at any particular stage, because of a higher mortality of one sex, it would have to be compensated for by an increased mortality of the other sex at another stage to result in the approximate equality at birth. This would presuppose a rather nice balance of the mortality rates at different periods. The simpler expectation would be a steadily increasing deviation, except for random divergences, from a start at equality to the particular ratio characteristic for the species at birth.

Critical data on mammalian prenatal sex ratios, based on actual determinations of the sex of large numbers of fetuses of known age, are relatively few. This has been supplemented, in some instances, by records of prenatal mortality, which can be used to estimate indirectly the prenatal sex ratio. For the most part, particularly in man, the pig, and the cow, these records indicate a situation quite different from the simple straight-line divergence from initial equality suggested above. In general, in these species there appears to be a considerable excess of males during intra-uterine life and both Crew and Parkes have argued that this predicates an even higher primary male sex ratio. Parkes has stated this argument clearly for the pig. He concludes:

* * * the percentage of males decreases as gestation proceeds, a result which can only be brought about by a differential mortality of males and females. It would appear that the percentage at conception must be very near 60 per cent. or 150 males per 100 females.

The initial ratio for man has been assumed to be about the same.

The careful observations of MacDowell and Lord on the mouse give results quite contrary to the conclusions drawn from previous data. These authors showed that when there was no embryonic mortality, as indicated by a correspondence between the number of corpora lutea of pregnancy and the number of young born, a 1 : 1 sex ratio resulted. Furthermore, when prenatal mortality has occurred, as shown by a discrepancy between the number of corpora lutea and the number of young in the litter, the amount of such mortality is not correlated with the sex ratio. From the first observation it is concluded that in mice "the primary sex ratio is * * * almost exactly 1 : 1," and from the second "that during gestation in mice there is no continuous selective elimination of one sex or the other before birth."

The conclusions drawn from the data on sheep, presented in this paper,

appear to agree more closely with those for the mouse. It is true that the sex ratio for embryos of the smallest class (under 5 cm) is high and significantly so, but there is reason to doubt the accuracy of some of the determinations in this class. From these smallest embryos to birth the deviations are random and insignificant; certainly they show no definite trend.

How may these discordant results and conclusions for different species be explained? There are several possible suggestions:

(1) That there are species differences with respect to the primary sex ratio.

(2) That the primary sex ratio is essentially one of the equality, but that in some species a high mortality of females in the early stages, before sex is ordinarily distinguishable, is followed by a later compensating mortality of males. In assuming that the trend in the later stages of pregnancy may be projected to estimate the primary sex ratio, little consideration has been given to the factors that might be causing a differential mortality during this earlier period. In the sheep, for example, distinguishable external differentiation of sex does not occur until about 45 days of pregnancy, which is about one-third of the whole period.

(3) That the data are in most cases too few or not sufficiently critical to permit definite and final conclusions.

The last suggestion emphasises the need of more critical data, not only on the sheep, but on as many mammalian species as possible.

Summary

An examination of the progeny records of the ewes among 5,000 sheep registered in the American Southdown Record gave a total of 6,116 registered Southdown births—3,409 singles, 2,656 twins, 48 triplets, and 3 quadruplets.

The frequencies of sex combinations in 1,994 complete twin-progeny records (that is, with both twins registered) gave 339 ♂ ♂ : 808 ♂ ♀ : and 847 ♀ ♀.

Of the animals registered as singles or twins in the American Southdown Record, 35.35 per cent. are males. This deficiency of males results from the commercial practice of reserving more females than males for breeding purposes.

A summary of 1,742 lambing records of all breeds kept at the Pennsylvania Agricultural Experiment Station gave 875 males and 867 females, with a sex ratio of 50.20 ± 1.20. Another summary of 433 lambing records of the Pennsylvania Station on registered Southdowns gave 218 males and 215 females, with a sex ratio of 50.30 ± 2.40.

The secondary sex ratio from these combined records is 50.20 ± 1.20.

A total of 972 prenatal lambs (495 males and 477 females) gave a sex ratio of 50.9 ± 1.60.

Prenatal growth curves are presented for length and weight.

XUM

A formula is given for estimating the fetal age of sheep from length in centimetres.

Mortality of sheep fetuses increases directly directly as the number of corpora lutea increases from 1 to 3.

There is no statistically significant difference between the sex ratios of the live and dead fetuses, or of fetuses deriving from ova from the right or left ovary, or both.

There is no evidence of a significantly higher mortality of either sex during the intra-uterine period.

Ovulation in the ewe is appreciably more frequent in the right ovary (58.58 ± 1.85 per cent.) than in the left.

The prenatal sex ratio found in sheep is essentially one of equality (50.9 ± 1.60).

[1] The author wishes to acknowledge his indebtedness to Drs. L. J. Cole and L. E. Casida, Department of Genetics, University of Wisconsin, for their guidance and encouragement, kind assistance, and patient and helpful criticism; to Col. E. N. Wentworth of Armour & Co., for his interest in securing the co-operation of the large Chicago packers in obtaining sheep fœtuses for this study; and to Armour & Co., and Wilson & Co., as well as to a large group of his co-workers and associates, appreciation for their co-operation in making possible this study.

Reviews

First Aid to Dogs and Cats. By M. H. CLARKE, M.R.C.V.S. Pp. x + 145. 52 Illustrations. London: Baillière, Tindall and Cox. Price 3s. 6d.

THIS compact book has been published at an opportune time. There are many dog and cat owners and others interested in the welfare of these animals to whom this publication will serve as a most useful guide. It is filled with information on the rendering of first-aid treatment and in order that the reader may grasp fully the nature of such treatment, brief but informative descriptions with illustrations are given of the anatomy and physiology of the various systems. Valuable sections deal with the handling of dogs and cats both in health and when sick or injured. The chapter (20) dealing with the feeding of dogs and cats in war time is also of considerable value.

To veterinary surgeons who are organising lectures and demonstrations on first-aid work this book is bound to be useful and one can visualise its being read by many of the members of N.A.R.P.A.C. whose duties lie among these animals.

Forewords to the book have been written by Col. R. J. Stordy, the Chief Executive Officer of the National A.R.P. for Animals Committee, Mr. H. W.

Steele-Bodger, the President of the National Veterinary Medical Association, Sir Robert Gower, Chairman, Animals' Welfare Group of the House of Commons, R.S.P.C.A. Council and National Canine Defence League Council, and by Mr. E. Keith Robinson, Governor and Secretary, Our Dumb Friends' League. Each points out the usefulness of the book, especially at the present time.

We have no hesitation in recommending strongly this book to veterinary surgeons for the use of the personnel working with them in the care of injured animals. It will lighten the task of instruction and will go a long way to educate those who have to undertake the care of such animals under his guidance.

The book fills a definite place in dog and cat work generally and the author is to be congratulated on its preparation and the publishers on its production.

News

ROYAL COLLEGE OF VETERINARY SURGEONS

CHANGE OF ADDRESS

THE Council has decided to remove the offices of the College to Harrogate. The address of the Secretary now is:

18, Victoria Avenue,
Harrogate.

CORRIGENDUM

The photographs produced in the November number of THE VETERINARY JOURNAL to face page 416 and illustrating Mr. Wilson Taylor's article were wrongly described. The descriptive matter of the two photographs should be transposed.

Publishers' Notices

All communications should be addressed to 7 and 8, Henrietta Street, Covent Garden, London, W.C.2. Telephone: Temple Bar 8568. Telegrams: "Baillière Phone, London."

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

Copy of advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 25th of the month, or if proof is required, not later than the 23rd.

Binding Cases for Volume 95 and any other previous volumes can be obtained from the publishers. Price 2s. 9d. post free.

Annual Subscription, 25s. ($6.00 U.S.A. currency), post free.

XUM

XUM

VOL. 96, NO. 11 & 12 DECEMBER 1940

JOHN CRERAR 1941

THE VETERINARY JOURNAL

A MONTHLY REVIEW OF VETERINARY SCIENCE

Est. 1875

PRICE: Single Copies 2s. 6d. (2s. 8d. post free); Annual Subscription 25s.

LONDON: BAILLIÈRE, TINDALL & COX
(Est. 1824)
7 & 8, HENRIETTA STREET, COVENT GARDEN, W.C.2

PRINTED IN GREAT BRITAIN ENTERED AS SECOND-CLASS MATTER IN THE U.S. POST OFFICE

XUM

ANTUITRIN 'S'

For the treatment of Sterility in Cattle

ANTUITRIN 'S' is an extract of pregnancy urine containing chorionic gonadotrophin (anterior-pituitary-like sex hormone). It exerts a stimulating effect on the gonads in male and female subjects.

Because of its stimulating effect on the interstitial cells of the testis Antuitrin 'S' is indicated for the treatment of bulls when sterility is due to oligospermia or azoospermia.

Anoestrus in cows may be associated with defective secretion of the anterior-pituitary gonadotrophic factor and the administration of Antuitrin 'S' is likely to restore the normal rhythm. Deficiency of the luteinizing factor which may inhibit conception may be likewise corrected by Antuitrin 'S'.

In these conditions it is necessary to give relatively large doses of Antuitrin 'S' by intramuscular injection and a specially high potency containing 500 rat-units (600 International units) per c.c. is supplied in 5 c.c. rubber-capped vials.

•

Parke, Davis & Co., 50, Beak St., London, W.1

Laboratories: Hounslow, Middlesex. Inc. U.S.A., Liability Ltd.

ABORTULIN

the new treatment for contagious abortion

Prepared by ABORTULIN LTD., LONDON.

ONLY SUPPLIED TO MEMBERS OF THE VETERINARY PROFESSION

Sole Distributors:

WILLOWS, FRANCIS, BUTLER AND THOMPSON, LTD.

Wholesale and Manufacturing Chemists

73, 75 & 89a, Shacklewell Lane London, E.8

Telegrams: "Forty, Hack, London" Telephone: Clissold 6361 (four lines)

FULL PARTICULARS SENT ON APPLICATION

The Veterinary Journal

DECEMBER, 1940

CONTENTS

PAGE

EDITORIAL—

Poultry Diseases 425
The Passing Year 426

GENERAL ARTICLES—

Fowl Paralysis. Transmission of Infective Agent to Young Chickens.
By R. E. Glover 427

Streptococcus Infections in Dogs.
By F. C. Minett and A. A. B. Ellis 438

A Disease of Chickens Apparently Identical with Nutritional Encephalomalacia.
By F. D. Asplin, M.R.C.V.S., Dip. Bact. 449

PAGE

CLINICAL ARTICLES—

Fibroma of the Bladder in a Bitch.
By G. H. Arthur, B.V.Sc., M.R.C.V.S. 453

Amputation of the Teat in Cattle.
By C. Wentworth Elam, M.R.C.V.S., D.V.H. 454

ABSTRACTS—

Prenatal and Postnatal Sex Ratio in Sheep.
By William Lewis Henning ... 455

REVIEWS 460

NEWS 461

CORRIGENDUM 461

DAVENIL *for infections in all animals.*

Davenil is used successfully in the treatment of a variety of endotoxic infections, notably acute septic conditions, coughs, corneal ulceration, ulcerative dermatitis, suppurative otitis, and post-operative healing.

(See "The Veterinary Journal," May, 1939, pp. 185-188)

Available in rubber capped phials of 50 c.c. at 20/-. (Less usual discount to veterinarians.)

A copy of this article and further literature will be sent on request.

A non-toxic anti-bacterial agent made by

ENDOCRINES-SPICER LTD., WATFORD, HERTS.

"YELLOWS"

CANINE INFECTIVE JAUNDICE

Prophylaxis and treatment are explained in literature describing

TRADE MARK **'WELLCOME'** BRAND

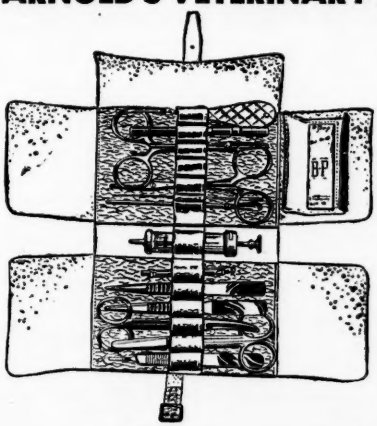
ANTI-LEPTOSPIRA SERUM
(CANINE)

and LEPTOSPIRA VACCINE
(CANINE)

Issued to Veterinary Surgeons only

Prepared at:
THE WELLCOME PHYSIOLOGICAL RESEARCH LABORATORIES
Supplied by:
BURROUGHS WELLCOME & CO., SNOW HILL BUILDINGS, LONDON, E.C.1
V 279 COPYRIGHT

ARNOLD'S VETERINARY INSTRUMENTS CASE



(For the Pocket)

56/- the Set.
Case only, 13s. 6d.

Packing and Postage 9d. extra.

Each Instrument can be sold separately. Any other instrument can be supplied to meet individual requirements. Full details of any instrument may be had on application. Initials can be stamped on Leather Case free of charge.

Prices are subject to alteration without notice.

A wide range of Instruments are in stock at

JOHN BELL & CROYDEN,
Wigmore Street, London, W.1.

Arnold & Sons

Veterinary Dept.: STANDARD WORKS, LAWRENCE RD., LONDON, N.15
Telegrams: Nusalin, Southtot, London. *Telephone: Stamford Hill 3456.*

INDEX TO ADVERTISERS

CHEMISTS

BROWNE, DR. J. COLLIS—Chlorodyne - - - - - - - - xx
DIMOL (VETERINARY), LTD.—'Dianimol' Preparations - - - - xvi
ENDOCRINES-SPICER, LTD.—'Davenil' - - - - - - - - iv
EVANS, SONS, LESCHER & WEBB, LTD.—Various Products - - - - xv
HEWLETT, C. J., & SON, LTD.—'Parophyroxia' - - - - - - x
MENLEY & JAMES, LTD.—'Vetiod' - - - - - - - - xvii
PARKE, DAVIS & CO.—Antuitrin 'S' - - - - - - - - ii
PHARMACEUTICAL SPECIALITIES (MAY & BAKER), LTD.—'Dagenan-M & B 693' - xi
SMITH & NEPHEW, T. J., LTD.—'Elastoplast' and 'Cellona' Bandages - - vii
WILLOWS, FRANCIS, BUTLER & THOMPSON, LTD.—'Abortulin' - - - iii

FOODS

COOPER, MCDOUGALL & ROBERTSON, LTD.—'Admin' - - - - - - ix
SPILLERS, LTD.—'Winalot' - - - - - - - - - xviii

SERUMS AND VACCINES

ALLEN & HANBURYS, LTD.—'Tubercle Vaccine R' - - - - - viii
BURROUGHS WELLCOME & CO.—Serums and Vaccines (Canine) - - - v
INTERNATIONAL SERUM CO., LTD.—Serums and Vaccines - - - - xiv

MISCELLANEOUS

ARNOLD & SONS—Veterinary Instruments and Medicines, etc. - - - v
BAILLIERE, TINDALL & COX - - - - - - - - xii, xiii, xviii
GLASGOW VETERINARY COLLEGE - - - - - - - - - xix
ROYAL (DICK) VETERINARY COLLEGE, EDINBURGH - - - - - vi
ROYAL VETERINARY COLLEGE - - - - - - - - - xix
UNIVERSITY OF LIVERPOOL - - - - - - - - - xix

MORTGAGES

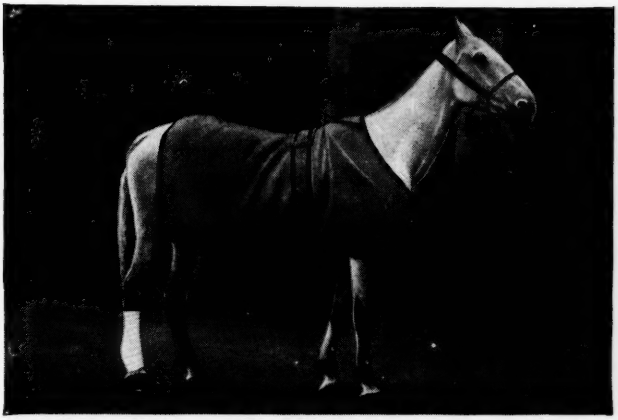
Mortgages available at 4½%, also 2nd Mortgages on Residences, Shops, Businesses, Farms, Hotels, Cinemas, Garages. Also Building Finance. Any district or town. Inquiries without obligation.—Write Selected Mortgage and Finance Investment Co., 6, High Street, Kingsland, London, E.8.

ROYAL (DICK) VETERINARY COLLEGE, EDINBURGH

Col. SIR A. OLVER, C.B., C.M.G., F.R.C.V.S., Principal.

THE SPRING TERM BEGINS ON 7th JANUARY, 1941

'Elastoplast' and Sprains in Animals



'Semiplast' supporting damaged off-hind fetlock following an infected wound involving the tendon sheath.

The oedema which frequently follows injuries to the tendons or joints in animals may be reduced by the application of 'Semiplast' or 'Elastocrepe,' either of which provides maximum *firm* and *even* support.

The 'Semiplast' Bandage is a half-spread form of 'Elastoplast.' It enables the limb to be bandaged so that only the first turn of plaster comes into contact with the hair.

The 'Elastocrepe' Bandage is made from the same yarns as 'Elastoplast' but without the adhesive spread. It possesses great tensile strength, and another of its outstanding features is that the elasticity of 'Elastocrepe' is renewed by the washing of the bandage.

Methods of applying the above-mentioned bandages and 'Cellona' Plaster of Paris Bandages are described in the handbook "*Elastoplast and Cellona Technique in Veterinary Practice*," a copy of which along with a professional price list of 'Elastoplast' products will be sent to Veterinary Surgeons upon request to T. J. Smith & Nephew, Ltd. (Dept. V.J.9), Hull.

'Elastoplast' and 'Cellona' Bandages

are made in England by

T. J. Smith & Nephew Ltd.

London, Hull, Manchester, Glasgow

Obtainable from all Chemists.

PROTECT THE NATION'S HEALTH

by immunizing all Calves against Tuberculosis

Bovine Tuberculosis is as great a menace as ever and, therefore, the co-operation of all individuals dealing with preventive medicine is required to reduce the incidence.

Tubercle Vaccine R

which was introduced into medicine by Dr. Nathan Raw, possesses powerful immunizing properties, and is strikingly effective in protecting the young animal against infection. The Vaccine is prepared from a non-pathogenic strain which has been rendered non-virulent by repeated subculture over a period of 23 years. It contains no living organisms and may, therefore, be used in relatively large doses with perfect safety.

Calf Immunizing Course consists of 2 doses
Price 5/-

Allen & Hanburys Ltd.

7 Vere Street, London, W.1

Telephone: Mayfair 2216 (3 lines)

Telegrams: "Vereburys Wesdo London"

Factors in Canine Nutrition

[No.11]

ADMIN and rickets

Tests have been carried out at our research farm as to the curative effects of ADMIN in cases of rickets. The disease was induced by feeding a known ricket-producing diet. Identical food was fed to both test animals and controls, with the exception that the test animals were given ADMIN as well. In this initial experiment only half the recommended daily dose of ADMIN was given. All the clinical symptoms had disappeared in 4 weeks and all the histological symptoms in 3 months. The outbreak of war has suspended a continuation of this experiment, but clinical improvement is to be expected within 10 days in most cases on the dosage recommended—i.e. from 1 to 3 teaspoonfuls daily.

What Admin Contains

ADMIN contains a minimum per pound of 15,625 international units of vitamin A; 3,906 international units of vitamin D; 2,510 international units of vitamin B1; and proportional amounts of the rest of the vitamin B complex and vitamin E, which have as yet no international standard. It supplies assimilable calcium, phosphorus, iron, copper, manganese, and iodine in the optimum quantities and proportions.

PACKETS 6d. and 1/6 (about ¼-lb. and 1-lb. respectively) are sold to the general public through chemists and corn chandlers. The 7/6 tin (containing about 7 lb.) is supplied to members of the veterinary profession at the special price of 5/6. Orders of 3 tins and over are sent carriage free.

ADMIN

FORTIFIES FOOD

Issued by
COOPER McDOUGALL & ROBERTSON LTD,
BERKHAMSTED, HERTS

HEWLETT'S

PAROPHYROXIÂ

The Perfect Colic Draught

ANTISEPTIC
PURGATIVE
CARMINATIVE

A well-tried remedy with a justly high reputation

Dose, 4-5 *fluid ounces, diluted.*

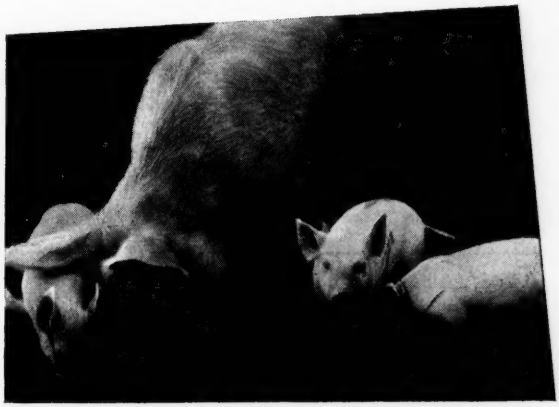
Samples on request to qualified Veterinary Surgeons only

C. J. HEWLETT & SON, LTD.

Manufacturing Chemists

35-43, Charlotte Road, LONDON, E.C.2

FOR PNEUMONIA IN *Pigs*



Dagenan-M&B 693

TRADE MARK

A MAY & BAKER VETERINARY PRODUCT

Losses of piglets through pneumonia associated with piglet influenza *suis* make up an important item on the debit side of the pig breeder's account. Experience on large pig farms has shown that the mortality rate may be considerably reduced by treatment with Dagenan-M & B 693 which has a specific action in this type of pneumonia.

DAGENAN—M & B 693 *is supplied in bottles of 25 gm. powder and containers of 25 and 500 0.5 gm. tablets.*

DAGENAN SODIUM—M & B 693 SOLUBLE *for parenteral administration is supplied in boxes of 25 c.c. ampoules and 10 × 3 c.c. ampoules.*

By prescribing original containers whenever possible wastage due to repacking is prevented, thus serving the interests of National Economy

PHARMACEUTICAL SPECIALITIES (MAY & BAKER) LTD., DAGENHAM

FIRST AID to

A Handbook for the technical personnel of the National A.R.P. for Animals Committee ; a Guide to all students of First Aid and a ready book of reference to small animal owners.

By MAURICE HARVEY CLARKE, M.R.C.V.S.

SOME OPINIONS

● **Colonel R. J. Stordy, C.B.E., D.S.O., M.R.C.V.S,**
Chief Executive Officer of the National A.R.P. for Animals Committee

" This Handbook of First Aid to Dogs and Cats is both timely and welcome. . . . With its useful illustrations it will prove not only a valuable source of reference to small animal owners but of great value to those giving first aid service. . . . Everyone undergoing instruction in the art of first aid will require a copy of this Handbook, which will be found a help to their study and an admirable book of reference."

● **H. W. Steele Bodger, M.R.C.V.S.**
President of the National Veterinary Medical Association

" An excellent little book which should prove of great value to those Animal Service workers and others who wish to understand the subject."

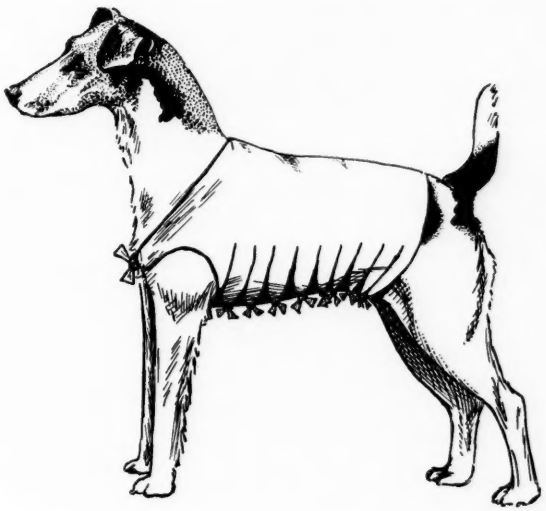
● **Sir Robert Gower, O.B.E., M.P.**
Chairman, Animals' Welfare Group of the House of Commons, R.S.P.C.A. Council, National Canine Defence League Council.

" Much suffering can be saved by knowing what to do before the doctor calls. I am confident that ' First Aid to Dogs and Cats ' will be the means of helping many to give relief to suffering animals until the veterinary surgeon arrives."

BAILLIÈRE, TINDALL & COX, 7 &

DOGS and CATS

Pp. x + 145. 52 Illustrations. Price 3s. 6d. **Just Published**



● **E. Keith Robinson**
Governor and Secretary, Our Dumb Friends' League

"A book of this kind has long been badly needed. We owe a debt to our animals and should be able to render them assistance when hurt. . . . I hope this book will be widely read."

7 & 8, Henrietta Street, London, W.C.2

MASTITIS

For the prevention and treatment of Mastitis we can recommend:

Mastitis Vaccine, R.S.G.

(For the prevention and treatment of Mastitis Catarrhalis).

In Boxes containing 10 × 10 c.c. (Ampoules).

Mastitis Vaccine B

We also supply a **SPECIAL MASTITIS VACCINE** which includes the organisms (Diplo-streptococci) found in many cases of the disease occurring in England and Scotland.

This vaccine is put up in bottles of 50 c.c. with puncturable rubber caps. Price 5/- per bottle. Dose: 5 c.c.

Excellent reports have been received as to the results obtained with this product.

Pyogenes Mastitis Serum
Pyogenes Mastitis Vaccine

(For the prevention and treatment of Mastitis due to B. Pyogenes Bovum infection). (Summer Mastitis)

Pyogenes Mastitis Serum is supplied in Bottles of 20 c.c. & 40 c.c.
Pyogenes Mastitis Vaccine is supplied in Ampoules of 10 c.c.

Mastitis Serum

(For the treatment of Acute Mastitis).

In Bottles of 50 c.c.

AUTOGENOUS MASTITIS VACCINE PREPARED

Price Lists and Literature on application.

International Serum Co., Ltd.

AYLSHAM, NORFOLK

Telegrams: "Serum, Aylsham." *Telephone:* 293.

VETERINARY **EVANS** PRODUCTS

Recent additions to Evans Veterinary Products

COLETYL
For controlling the activity of the circulation and visceral organs.
Issued in 25 c.c. rubber-capped bottles.

DIARSIN
A 5 per cent. solution of the disodium salt of acetarsonic acid indicated in malnutrition, asthenia, exhaustion, anæmia and allied conditions.
Issued in 1 c.c. and 10 c.c. ampoules.

HEPATEX-T. VETERINARY
A solution of liver containing the natural vitamin B complex with the addition of pure crystalline vitamin B_1 and nicotinic acid. Hepatex-T is a specific treatment for blacktongue in dogs. It is a valuable tonic in anæmia and general debility.
Issued in 2 c.c. ampoules and 10 c.c. rubber-capped bottles.

HEPRONA VETERINARY
An oral preparation containing liver, iron, sodium glycerophosphate and vitamins B_1 B_2 and C.
Issued in 6, 12, 40, and 80 fl. oz. bottles.

PIREVAN
A specific for the treatment of redwater fever and other piroplasmoses.
Issued in 10 c.c. ampoules.

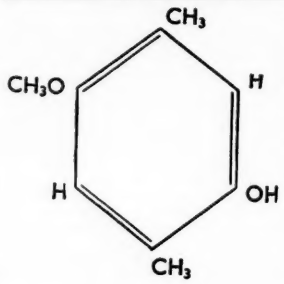
STREPTOCIDE OINTMENT VETERINARY
An ointment containing 5 per cent. of Streptocide (Sulphanilamide Evans). Suitable for local application for wounds and superficial ulceration of the skin. Streptocide Ointment is also recommended for ophthalmic use.
Issued in 2 oz. tubes and 1lb. tins.

Technical literature concerning any of the above products will be sent on application to Home Veterinary Dept., Hanover Street, Liverpool.

Evans Sons Lescher and Webb Ltd.
Liverpool and London.

"DIANIMOL"

Veterinary Preparations



Prepared to a standard bacterial co-efficient from the world-famed intestinal antiseptic DIMOL (R. W. Co. 43) non-toxic, non-absorbent, non-accumulative, harmless to the weakest animal.

DIMETHYLOMETHOXYPHENOL

"DIANIMOL" PESSARIES

For Sterility and Contagious Abortion.

Each Pessary contains
15 gr. "DIMOL" Powder.

Ordinary Infection. Insert one every third day during infection period. NOTE—In badly infected cases two may be used to commence with.
Preventive and Routine Use. One a week or so before service.
Contagious Abortion. Two for first insertion and then one every other day as required.

NON-IRRITANT - RELIABLE.

Boxes of 12 ... 3/6

	Bottles of 2-oz.	4-oz.	16-oz.	1-gal. can.
LIQUID (Antiseptic Solution) (Dilute 1 to 40 for general use)	**1/3**	**2/-**	**5/6**	**30/-**

	2-oz. tin.	4-oz. tin.	16-oz. tin.
OINTMENT	**1/6**	**2/6**	**8/-**

SAFE, POWERFUL, PENETRATING.

Special Terms to Veterinary Surgeons and Institutions.

DIMOL (VETERINARY) LIMITED,
34/40, LUDGATE HILL, LONDON, E.C.4.

TELEPHONE: CITY 6309 TELEGRAMS: "DIMOLAIN" CENT, LONDON

WHY
YOU SHOULD USE
VETIOD

A leading Veterinarian writes:—"I cannot understand why Vetiod gives such satisfactory results so quickly".

There are five good reasons for the superiority of Vetiod over ordinary iodine preparations:

Vetiod is more active and more efficient than the Tincture.

It is rapidly penetrating.

It is absolutely bland, even on mucous surfaces.

It can be liberally and frequently applied without risk of irritation, or injury to the animal's coat or hair.

It is the application *par excellence* in wounds, tumours, ringworm, mange, parasitic skin affections, and inflammations generally.

THE IDEAL FORM OF IODINE FOR VETERINARY USE

Samples for clinical trial will be gladly sent on request

MENLEY & JAMES LTD., 123 COLDHARBOUR LANE, LONDON, S.E.5

CONSISTENT NUTRITIONAL VALUE

ANALYTICAL and biological tests ensure the consistent nutritional value of WINALOT — the Dog's Wholemeal Food.

The special dietetic factors of WINALOT, which is obtainable in Meal or Biscuit form, are derived from wholemeal flour with added wheat-germ, cod-liver oil and other vitamin and mineral supplements— in correct balance and in full potency, unimpaired by the process of manufacture.

WINALOT

The Dog's Wholemeal Food

containing :

VEGETABLE PROTEINS
FATS & CARBOHYDRATES
BALANCED MINERALS
ESSENTIAL VITAMINS

A Product of Spillers Limited

DISEASES of the PIG

AND ITS HUSBANDRY

by

David J. Anthony, M.R.C.V.S

10s. 6d.

"It is in the main first rate, and may be called indispensable . . . It may well become one of our professional classics."
—VETERINARY RECORD.

"Of considerable value to veterinary surgeons, especially those practising in pig-rearing districts."
—VETERINARY JOURNAL.

"Mr. Anthony certainly achieves his object so far as the Veterinary Profession is concerned."
—FARMER AND STOCK BREEDER.

"Mr. Anthony's book will be welcomed by all who have to deal with the modern pig and its troubles."
—COUNTRY LIFE.

BAILLIÈRE TINDALL & COX

7 & 8, *Henrietta St., London, W.C.*2

THE GLASGOW VETERINARY COLLEGE

(Incorporated)

83, BUCCLEUCH STREET, GLASGOW, C.3.

Courses of Instruction are given for

The Diploma of M.R.C.V.S.
The Degree of B.Sc. in Veterinary Science
The (advanced) Diploma of D.V.S.M.

WOMEN STUDENTS ARE ACCEPTED

For full particulars apply to the Principal.

ROYAL VETERINARY COLLEGE

All communications for the Principal should be addressed to:

Royal Veterinary College,
Streatley House,
Streatley, Reading, Berks.

THE UNIVERSITY OF LIVERPOOL

School of Veterinary Science.

Students are prepared for:—

1. The degrees of Bachelor of Veterinary Science (B.V.Sc.), Master of Veterinary Science (M.V.Sc.) and Doctor of Veterinary Science (D.V.Sc.). The Doctorate in Philosophy may also be taken in Veterinary subjects.

2. The Diploma of Membership (M.R.C.V.S.) and the Fellowship (F.R.C.V.S.) of the Royal College of Veterinary Surgeons. The Diploma of Membership is the legal licence to practise Veterinary Medicine and Surgery in this country.

Certain Courses in the School qualify for admission to first examinations for Degrees of M.B., Ch.B. and B.Sc.

Post-Graduate Courses in Comparative Pathology and Bacteriology are also specially arranged for Officers of the Army Veterinary Department, Colonial Veterinary Surgeons and others.

Full particulars as to Preliminary Examinations, etc., together with Prospectuses of the School and Doctorate in Philosophy, may be obtained on application to the Registrar, The University of Liverpool. Early application is essential, as accommodation for first year Veterinary Students is limited.

XUM